Improved weed management in the Near East

FAO
PLANT
PRODUCTION
AND PROTECTION
PAPER

80

FOOD
AND
AGRICULTURE
ORGANIZATION
OF THE
UNITED NATIONS

Improved weed management in the Near East

Proceedings of the
FAO Expert Consultation
on Improved Weed Management
in the Near East

Nicosia, Cyprus
30 October - 1 November 1985

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PREFACE

In most countries of the Near East, weed management is still not viewed in the same perspective as other plant protection activities as far as teaching, extension and research are concerned. In fact, little attention is being paid to this very important field of plant prctection. As a result, poor weed control is still a major factor of the low yields of food crops in the Region. The FAO initiative in staging the Expert Consultation on Improved Weed Management in the Near East was intended to highlight this situation and to draw national and regional attention to the severe losses caused by weeds, to the deleterious impact on fragile agroecosystems of traditional weeding practices, and to the burden and impracticability of control measures adopted at present. The other objective was to assist the Near East member governments in the establishment of improved weed management programmes.

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SECTION A

REPORT AND RECOMMENDATIONS OF THE CONSULTATION

REPORT AND RECOMMENDATIONS

I. INTRODUCTION

In the opening session, Dr. Taher, FAO Regional Plant Protection Officer for the Near East, welcomed all participants to the Consultation on behalf of the Director-General of FAO and thanked the Government of Cyprus for hosting the meeting. Thanks were also expressed to the Arab Organization for Agricultural Development [AOAD], the International Centre for Agricultural Research in the Dry Areas [ICARDA], the International Group of National Associations of Manufacturers of Agrochemical Products [GIFAP], the Germany Agency for Technical Cooperation [GTZ], and the European Weed Research Society [EWRS]. Dr. Taher indicated that the member countries of the Near East region fall within the developing countries where the level of production of food crops presently lags behind that reached in developed countries. The lack of proper weed management was recognized as being one of the primary contributory factors. He stated that FAO expected the consultation to assess the overall and individual situation in the Near East, and to come forward with useful recommendations for future action on improved weed management. He assured the meeting that FAO would provide all the assistance that its resources could permit to support valid initiatives.

H.E. the Minister of Agriculture and Natural Resources in Cyprus, in addressing the meeting, welcomed the participants, outlined the weed problems in the region and expressed his confidence that the consultation would be fruitful and lead to close regional cooperation.

II. ELECTION OF CHAIRMAN AND DRAFTING COMMITTEE AND ADOPTION OF AGENDA

The meeting endorsed the suggestion that the Chairman and Vice-Chairman for the three sessions should be elected in rotation. The following participants were elected:

Wednesday, 30 October Session:	Chairman - Mr. P. Americanos
	Vice-Chairman - Dr. A. Hamdoun
Thursday, 31 October Session:	Chairman - Dr. A.R. Saghir
	Vice-Chairman - Mr. G. Markoullis
Discussion Sessions:	Chairman - Dr. W. Koch
	Vice-Chairman - Mr. C. Parker

Elected participants also served in the Drafting Committee together with the FAO Technical Secretariat.

The meeting also endorsed the proposed agenda (Annex 1).

III. SUMMARY OF PAPERS

Future Trends in Agriculture in the Arab World

Dr. Azrag highlighted the problem of food security in the Arab world which had deteriorated during the decade 1972-1982. Thus the food gap in cereals had increased by 13% annually and food imports had increased by 20% annually. Total cultivated area had increased only slightly, while population increase had reached a level of 2.8% per annum. During the same period, lack of technological improvement had resulted in the deterioration of productivity. Capital investments allocated to Agriculture were low and so were the returns on capital. Dr. Azrag mentioned that low yields are attributed to low rainfall and that the main production constraints are poor agronomic practices and lack of supporting services. He stated that herbicide usage is very limited, farmers resorting to hand weeding. Apart from that, no effective weed control was carried out. Dr. Azrag indicated that within the Arab world there is a shortage of qualified weed scientists and extension workers, and that the unavailability of herbicides and application equipment in many countries makes progress very difficult.

Weed Management in Dryland Cereal Production

Dr. Kukula presented evidence from several trials in Syria pointing to the importance of weeds in cereals, particularly in wheat. He referred to traditional weeding methods, stating that they are not effective because weeds are removed after they have already caused some yield reduction. He felt that there was considerable scope for herbicides and good cultural practices (e.g. higher seed rates, closer spacing, increased N and P fertilizers, early sowing, suitable varieties) in increasing crop productivity. He indicated that monoculture has aggravated the wild oat problem and also that tillage systems must vary according to soil type, while integrated weed control can be achieved in a proper rotation. The general conclusion was that herbicide use on wheat had a very favourable effect on yields and was economically justifiable. In barley, which is a competitive crop, chemical weed control may not be necessary.

Weed Management in Vegetable Production

Dr. Saghir's presentation clearly indicated the very adverse effect of weeds on vegetable production. According to his findings, elimination of early weed competition is of paramount importance. The parasitic weeds, Orobanche, Cuscuta and Striga are very damaging to susceptible vegetable hosts. The future outlook necessitated that, in view of the high labour costs and the availability of selective herbicides for vegetables, weed experiments be carried out in each country. Research should aim at improving the present weed control practices by adopting new techniques. Training and extension

programmes should accompany the research effort. Implementation of strict quarantine measures is also required to prevent the spread of weeds and the introduction of new species. From the discussion, it appeared that there was a need to study the residual effects of herbicides in order to avoid carry-over problems in subsequent crops.

Weed Management in Orchards

Mr. Collins described weed control practices in the orchards of many Mediterranean countries and he enumerated the pros and cons of chemical weed control. Although in the majority of the countries of the Near East weed control was based almost exclusively on tillage, evidence from other countries suggested that no-tillage often resulted in increased yields. Although this concept was fairly new, it was gaining momentum. In the discussion that followed, different views were expressed, both in support and in opposition to the no-tillage system. Mr. Collins mentioned that the chemical industry had enough information on these cropping systems, and expressed a wish that FAO and other international organizations should cooperate with industry in profitably using the information available to the advantage of the farmer.

Aspects of Weed Management Considering Alteration of a Traditional Cropping System

Dr. Jansen described the efforts to change the production system of wheat in Syria to meet the need of raising production by at least 10%. One way to achieve this was to abandon the fallow system; another was to increase yield with high yielding varieties, fertiliz-tion ation and weed control. It was pointed out that under practical conditions, chemical weed control with hormone weedkillers very often did not result in a yield increase. The use of herbicide mixtures was suggested, but it was felt that it would be uneconomical.

Parasitic Weeds and their Control

Mr. Parker discussed in detail the four main groups of parasitic weeds, their distribution pattern and importance on various crops of economic value in the countries of the Near East. These were dodders (*Cuscuta* spp.), which attack a wide range of cultivated crops, broomrapes (*Orobanche* spp.), witchweeds (*Striga* spp.) and mistletoes (*Viscum* and other species). With regard to the measures for controlling these problems, Mr. Parker stressed the use of preventive methods. These should be adopted for all four groups. Of all the methods, the use of clean seed is the most important. He elaborated on other control measures such as mechanical elimination of the parasites, and on suitable cultural practices. These included crop rotation, shifting of planting dates, elimination of parasitized weeds around the crop, biological control, chemical measures by the use of various compounds, and breeding and selection of resistant varieties. Furthermore, in the case of *Striga*, nitrogen application and stimulants might be help-

ful in reducing infestation. With regard to Orobanche, solarization by covering the soil with plastic during the summer might be helpful in reducing the germination capability of Orobanche seeds. Quarantine regulations, both nationally and internationally, would help to prevent the further dissemination and wide spreading of troublesome parasitic weeds.

Storage and Distribution of Weed Management Data

In discussing storage and distribution of weed management data, Dr. Koch gave priority to the following points:

1. Transfer of data stores, their transformation and distribution had to be chosen according to the respective target groups.
2. Techniques for storage and retrieval of data had to be chosen according to clearly defined objectives and according to local needs and possibilities. The simplest and cheapest technique, which would best serve a given purpose, was to be selected.
3. Ways of possible cooperation between institutions and responsible individuals must be identified. FAO should play a coordinating role in this respect.
4. Major weed management problems of the Near East, which so far had not been properly considered in publications, were to be defined during the consultation and respective publications be recommended.

Country Status Papers

The status paper of weed management in Cyprus was presented by Mr. Americanos. He touched very briefly on various aspects, problems and facts about agricultural production in the country, and emphasized certain weed problems and the assessment of crop losses, the positive attitude of the Cyprus farmers towards weed control, and various other points. He further mentioned that Cyprus farmers, due to the great shortage of labour, were more in favour of using herbicides for the control of weeds than using any other method. Efficient extension methods were used for the training of Agricultural Beat officers and farmers in weed management, and the results could be considered very satisfactory. These results were reflected in the high percentage of cropped area treated with herbicides. Various suggestions were made for improved weed management. These included work on tolerant weeds, herbicide residues, use of safeners and herbigation. Mr. Americanos suggested that regional cooperation in weed management should prevail in the region.

Dr. Ibrahim described the situation in Egypt. He stated that weed management in most parts of the country was still performed conventionally either by hand-hoeing or ploughing. He recommended that special attention should be paid to mechanized cropping systems. He

also suggested strengthening education, extension and research in weed control. Dr. Ibrahim emphasized the need for special programmes aimed at motivating the adoption of new technologies.

Mr. Mirkamali presented a paper on Iran. He mentioned that weeds induced more crop losses than those caused by disease organisms and insects. Conventional methods of weed control were still being used by small-scale farmers. The most important weeds were Phalaris, Dichanthium and Imperata spp., aquatic and parasitic weeds. Some of the improved weed management practices suggested by Mr. Mirkamali included the establishment of training centres, and offering training courses in weed management at both farmer and university levels.

Mr. Alkaisi discussed weed management in Iraq. He mentioned that the most important weeds included Imperata cylindrica, Cynodon dactylon, the parasitic weeds Orobanche and Cuscuta and the aquatic weeds Phragmites and Typha. The most economical crops were wheat, rice, vegetable crops and date palms. The most commonly used herbicides were 2,4-D, propanil, dalapon and glyphosate. Some of the existing problems in weed management in Iraq included environmental pollution and the inefficient control of perennial and parasitic weeds.

Dr. Abu-Irmaileh reviewed the agriculture status in Jordan, which was characterized by reliance on rainfall. The erratic and poor distribution of rain led to the instability of crop production. Advanced technologies were not adopted in most rainfed areas, mainly because of lack of knowledge and their high cost. However, in the irrigated Jordan valley, farmers invested in such technologies since the cost/benefit ratio was rewarding. Despite this interest, weed management in most areas was not properly met. It was suggested that training in weed control extension and research be strengthened and emphasized. It was also suggested that the private sector should be encouraged to take an interest in the subject of weed management. It was emphasized that the government should also subsidize the cost of weed control and make herbicides available at prices which the farmers could afford. Regional and international meetings should also be held in order to discuss new advances in weed management.

Dr. Saghir presented his status paper on Lebanon, and reviewed the weed problems and losses in various crops. He indicated that grass weeds (Avena, Lolium and Phalaris spp.) and 2,4-D tolerant broadleaved weeds (Anthemis and Polygonum spp.) were becoming a problem in cereal fields. He stressed the importance of legislation for a seed law which would prohibit the introduction of parasitic weeds. He suggested that extension, training, education and research in weed management should be strengthened in the public sector as well as in private institutions. He mentioned that improved weed management in Lebanon and the Near East region will develop as a result of weed research. Such efforts should focus on conducting weed surveys in the region, on developing formulations and additives to improve selectivity of already existing cheap herbicides, on using simple

herbicide application techniques and on implementing an integrated weed management programme. He concluded that weed science should be recognized as an essential discipline at universities, research institutes, international centres and organizations, and should be included in the list of priorities of ministries of agriculture of the region.

The country status paper of Morocco, presented by Mr. Mouch, highlighted the important noxious weeds in wheat. These were Bromus spp., Phalaris spp., Lolium spp., Avena sterilis, Convolvulus arvensis, Galium tricorne, Thesium humile and Astragalus baeticus. Echinochloa crus-galli was the most serious weed in rice, Orobanche crenata parasitized some legumes and had been controlled by glyphosate in Vicia faba. Phragmites communis was now on the increase in irrigated wheat and rice. P. communis and Typha angustifolia were heavily infesting irrigation canals. Cuscuta was creating problems in olives, alfalfa and tomatoes. Perennial weeds in orchards were Cyperus rotundus and Cynodon dactylon. The serious problem weed in vegetables was Oxalis cernua. Zizyphus lotus was widely spreading. Solanum elaeagnifolium was a new adventive weed and an increasing problem. Finally, Mr. Mouch made some suggestions aiming at the strengthening of weed science in Morocco.

Dr. Shad presented his paper on weed management in Pakistan. He reported that crops suffered yield losses ranging from 15 to 100%. Weed control in Pakistan was still conventional and characterized by intensive ploughing, hand and mechanical weeding. As an alternative, chemical control was still negligible. He emphasized the need for training in weed control extension, teaching and research. He also pointed out the need for literature-exchange in weed management and for the strengthening of weed science at the institutional level. He also stressed the need for establishing weed science societies in the region.

The country status paper of Sudan, presented by Dr. Hamdoun, illustrated the severity of weed infestations in the White Nile, canalization and drainage system as well as in arable crops. Losses, resulting from unrestricted weed growth, delayed weeding or insufficient weeding were considerable. Both the farmer and the government were concerned about the problem and were trying to resolve the situation by using mechanical, chemical, cultural, manual and legislative measures of control. Research had made significant advances in the biology of some weed species, competition between crops and weeds and on chemical, cultural, mechanical and biological control. M.Sc. courses were run in universities. Research findings, however, did not reach the farmers because of ineffective extension.

IV. RECOMMENDATIONS

Introduction

Noting the serious downward trend in food self-sufficiency in most Arab countries, as revealed in detailed surveys by the Arab Organization for Agricultural Development, and considering the burden this placed on the economies of these countries, the consultation welcomed evidence from several participants that, with suitable integration of improved weed management and cultural practices (involving time of planting, fertilization and cultivation methods), great increases in cereal and other crop yield could be obtained even under low rainfall conditions. However, exploitation of these integrated techniques and many other potential contributions of improved weed management were failing due to lack of research, extension and training capacity in weed science. The consultation, therefore, urged all individual countries of the region to take proper steps to ensure the awareness of decision-makers of the high economic and ecological relevance of proper weed management. It also urged the respective countries to adopt the following recommendations in order to benefit their individual farmers and national economies:

Staffing needs

1. Noting that many of the countries of the Near East had only a single individual weed scientist to cover a wide range of different crops and ecological situations, while some had none at all and in none was the number adequate, the meeting recommended national governments to create additional research posts and to seek bilateral and international help as necessary for training, information, literature and equipment requirements. The meeting further recommended that the weed research programme of ICARDA be maintained and strengthened to provide a base for longer-term field research, for some forms of training and for weed science information of the region.

2. Noting that research results, even where they had been achieved, were not yet fully benefiting the farmers of the region because of inadequate links between research and extension services in respect of weed management, the meeting recommended the urgent creation of full-time weed management subject matter specialist posts in the extension service to work closely with research teams and provide the essential two-way flow of information between research workers and the farmer. The specialist should have adequate crop production background with at least some specialized weed science training and have adequate logistical support and resources.

Training needs

Noting the very limited capacities within the region for the training of weed researchers and extension specialists, the meeting recommended national governments to seek bilateral and international

assistance in strengthening of University staffing and courses in weed science at the undergraduate and postgraduate levels, and in arranging and financing in-country short courses for weed research and extension personnel. The possible contribution of GIFAP in such courses was noted with appreciation. Local staff, once adequately trained, should in turn intensify the training of local extension officers and spray-operators in the safe and effective use of herbicides and other weed management practices.

Research needs

Noting the serious lack of site specific research results which would be necessary for improving weed management in crop production systems and for demonstrating the ecological and economic importance of proper weed management strategies, the meeting recommended that, in deciding weed research priorities, particular attention should be focused on the potential for integration of improved weed control techniques into cropping systems where cultivation, fertilizer use and other cultural practices, and their interactions, were all considered. Such studies would require close liaison with crop production specialists, engineers and economists. Other topics deserving consideration included: all aspects of the parasitic weeds, Orobanche, Cuscuta and Striga, and the potential for their biological control; the problem of tolerant and resistant weeds in cereals; perennial weeds; and the optimization of herbicide use, exploiting herbicides and new techniques where appropriate.

New publications

1. Recognizing the need for manuals and guidebooks for the use of extension services, the meeting recommended that arrangements be made with FAO or other suitable agencies, such as AOAD and ICARDA, for the production of relevant literature and leaflets (in both English and Arabic) for regional use, including (a) a guide to the identification and control of parasitic weeds and (b) a guide to weed management strategies for cropping systems of the Near East region, with special emphasis on cereal production.

2. Noting that the relevant literature was not sufficiently known to everybody who would need this information, the meeting recommended that proper steps be taken to ensure the necessary exchange of information.

Legislation

Noting the well-known problem of movement and introduction of parasitic dodder (Cuscuta spp.) in contaminated crop seeds, and the risks of similar introduction of other parasitic and noxious weeds, the meeting recommended that each country in the region enact legislation requiring the certification of all imported seeds of alfalfa and other relevant crops, as having been grown on land completely

free of designated parasitic or other noxious weeds and/or being free of the same designated weed seeds. Such certification and noxious weed regulations should also be introduced within the country as appropriate, to prevent the spread of potentially serious weed problems. The meeting also recommended that EPPO be approached to prepare model legislation relating to other aspects of quarantine and control of movement of noxious weed species.

Noting the increasing importance of herbicide use in the region, the meeting recommended that all countries of the region should adopt the FAO International Code of Conduct on the Distribution and Use of Pesticides.

Coordination and stimulation of weed management activities in the Near East

Noting that the consultation offered the first opportunity for most weed scientists of the region to meet, and that many crop and weed problems were common to a number of countries, the meeting agreed on the need for the creation of a "Near East Working Group for Improved Weed Management" with the following terms of reference:

(a) To activate and support national/regional programme(s) on Improved Weed Management,

(b) To obtain and distribute up-to-date information on Improved Weed Management,

(c) To convene ad hoc meetings of weed scientists and technical personnel involved in Improved Weed Management,

(d) To distribute information on on-going Improved Weed Management national and regional projects and quantify, when possible, their achievements,

(e) To liaise with the FAO Panel of Experts on Improved Weed Management and other international and regional organizations and societies concerned.

Participation in the Near East Group for Improved Weed Management would be open to all technical staff directly involved in weed control in the region. The group would be expected to function on an informal basis under the guidance of a steering committee. The following were elected to this committee:

Dr. A.R. Saghir	Chairman
Mr. P. Americanos	Vice-Chairman and Secretary
Dr. A.M. Hamdoun	Member
Mr. M. Mouch	Member
Dr. R.A. Shad	Member

V. ADOPTION OF THE REPORT

The draft report of the Consultation was adopted.

VI. CLOSURE OF THE MEETING

Dr. Taher expressed his appreciation to the Ministry of Agricultural and Natural Resources for its generous hospitality and excellent facilities. He also thanked all those who contributed to the success of the meeting, whether from international or regional organizations and societies or from national institutions. He concluded by saying that it was essential that the recommendations of the meeting, whether addressed to member governments or to organizations, should be followed up closely and implemented.

SECTION B

OPENING OF THE CONSULTATION

ADDRESS OF WELCOME

Dr. M.M. Taher
Regional Plant Protection Officer for the Near East
Food and Agriculture Organization of the United Nations

Excellency,Minister of Agriculture and Natural Resources
Honorouble guests, distinguished participants.

On behalf of the Director-General of FAO and the Assistant Director-General for the Near East, it is a pleasure to welcome you on the occasion of the Expert Consultation on Improved Weed Management in the Near East. I would like here to thank especially the Government of Cyprus and His Excellency the Minister of Agriculture and Natural Resources for hosting this meeting and for providing every possible necessary support. I would also like to thank the Arab Organization for Agricultural Development, the International Center for Agricultural Research in the Dry Areas, the Arab Society for Plant Protection, the International Group of National Associations of Manufacturers of Agrochemical Products, the German Agency for Technical Cooperation (GTZ), and the European Weed Research Society for their positive contributions to the consultation.

The member countries of the Near East region fall within the developing countries where the level of production of food crops presently lags behind that reached in developed countries. This has been attributed mainly to pest problems and to inadequate crop management. In both cases, the lack of proper weed management is always the prime contributory factor of reduced or poor yields.

In addition to straightforward crop losses caused by weeds (due to their competition for water, nutrients, light and oxygen), weeds interfere with farm operations, they lower the quality of harvest through contamination, increase the moisture content in certain products, host pests and diseases and can cause food and forage poisoning. Farmers in developing countries still spend up to 80% of their time on traditional methods of land preparation and weed control. Often these methods are laborious and ineffective and, in general, they contribute to the reduction of soil fertility and soil moisture.

Weed management in most countries of the Near East is still not viewed in the same perspective as other plant protection activities and agronomic practices, and still has a lower priority as far as teaching, extension and research are concerned.

The foregoing is also true for most developing countries outside the Near East. FAO is now playing a leading role in assisting

in the development of improved weed management methods at the national, regional and global levels. To strengthen these activities, a Panel of Experts on Improved Weed Management was established in 1983. This Panel has the direct responsibility of advising and assisting FAO on all aspects of improved weed management with particular emphasis on developing countries.

FAO expects this consultation to assess the overall situation in the Near East and individual countries' capabilities in terms of weed management. This should stimulate fruitful discussions and yield useful recommendations for future action programmes. These programmes, in turn, should aim at improved weed management in the short and long term.

I would like to assure you that FAO will provide all the assistance that its resources permit to support valid initiatives that member countries will take in the implementation of the recommendations of this consultation.

Lastly, I would like to thank all the participants for their positive contributions and wish them a successful consultation and a pleasant stay in Cyprus.

ADDRESS OF WELCOME

H.E. The Minister of Agriculture and Natural Resources Cyprus

Your Excellencies,
Ladies and Gentlemen

On behalf of the Government of Cyprus I wish to express my pleasure at hosting this FAO Expert Consultation on Improved Weed Management in the Near East, ths first of its kind.

The subject of this consultation is of great importance, not only to Cyprus, but to the whole of the Near East. Wesds havs plagued man since the dawn of time and have hindered his sfforts to produce food and fibrs. Ths dstrimental effect of weeds in crops is universally recognized. Losses due to weeds are enormous, and although no figures are available world wide, it is safe to say that these losses run into billions of dollars annually. In the United States alone, for which data is available, losses dus to weeds exceed 15 billion dollars a year. In Cyprus research in soms crops has shown that weeds can reduce yields between 10 and 100 per cent. Vegetables such as celery and open crops such as the onion are the most vulnsrabls.

Weeds are certainly a significant factor in the economics of agriculturs and it is important to sxpress this significance in monetary terms which are understood not only by the farmers but by the public at large.

Weeds have always been present, but because thsy lack ths drama and publicity of sudden and severs outbreaks of disease or insects, their importance tends to be undsrestimated. Their importance, however, is reflscted by the fact that world wide more hsrbicides are manufactured and sold than insecticides and fungicides put together.

The neceeeity of managing weeds cannot be overemphasized. Cyprus, together with othsr neighbouring countries, has a climats that encourages the rapid and abundant growth of weeds. Recognizing the significance of containing the weed problem the Government encouraged, back in 1953, the introduction of hormone wesd-killers for uss in cereals. Uss of chemical weed control methods progressed slowly until the mid-sixties. Sincs thsn thsir use has sxpanded, mainly for two reasons. One, because ths Governmsnt established the Agricultural Research Institute in which Weed Control was a basic activity, thus generating local data on herbicide use in many crops, and two, because of economic factors relating to ths scarcity and high cost of hand labour. It is indicative of the progress made over the last 20 years that while in 1965 only about

10,000 kilos of a limited number, 6-8 herbicides were used, in 1983 the quantity exceeded 820,000 kilos and the number of herbicides sold was over 50. Research into chemical weed control methods has produced results and recommendations for over 20 crops, including all the major ones in the island. It is estimated that the benefit to the farmers from adopting these recommendations exceed C£ 5 million annually.

In most cases our farmers have been quick at adopting the use of recommended herbicides. Cereals with an area of around 52,000 ha and potatoes with an area of 8,000 ha are routinely treated with herbicides, while in vineyards it is estimated that around 80% of the total area of ca. 34,000 ha is also treated. Herbicides are also being used in most vegetables. In tree crops growers have been slow in adopting chemical weed control methods because of the ease of cultivation. However, this is now changing because the gradual installation of permanent irrigation systems almost preclude the use of tillage implements.

Although our farmers have free access to a large number of herbicides, importation and marketing of a herbicide is subject to registration which can only be granted if the Registration Authorities are satisfied that it is safe for use in the crops for which registration is being sought, at the rates recommended on the specimen label.

Information on chemical weed control methods is freely available to our farmers through the Extension Service of the Department of Agriculture, which is well organized and staffed with qualified personnel. Training courses are often organized for the benefit of farmers but also, on a higher level, for the Extension staff itself.

Although chemical weed control is generally quick and cost efficient, it is only one aspect in the battle against weeds, and in the framework of weed management. There are many other aspects that warrant attention such as the containment of escaping resistant weeds, the effect of herbicide use on soil erosion and the water economy of crops, herbicide residues, efficient methods of application and many others. Our research programme for the immediate and near future includes provision for the study of more aspects and in welcoming you all to this consultation I wish to express my confidence that the exchange of ideas which will result will have a beneficial effect on our common efforts to manage weeds.

Thank you.

SECTION C

REVIEW PAPERS

FUTURE TRENDS IN AGRICULTURAL PRODUCTION WITHIN THE ARAB COUNTRIES

El Sadig E. Azrag
Arab Organization for Agricultural Development
P O Box 474, Khartoum, Sudan

INTRODUCTION

Geographically, the Arab world extends from the Arabian Gulf in the east to the Atlantic Ocean in the west. It lies between latitudes 15° south and 35° north and longitudes 40° east and 16° west. It has an overall length of 7500 km, a width of 3000 km and a total area of about 1413 million ha. According to the 1982 censuses about 180 million live in this area. The rural population is estimated to be 91 million. The total area of arable land is 198 million ha and only 25% (51 million ha) of it is under production. Eighty percent of the cultivated land is rainfed and the remainder is irrigated. Pastures and forests occupy 268 million ha and 145 million ha respectively. Table 1 shows the relative importance of the agricultural sector to the GDP of Arab countries.

The Arab world is actively involved in all aspects of agricultural production. For the purpose of this paper and because of the ever present threat of food shortages in the world today, only some aspects of production, including weed management, of cereal crops are considered. Table 2 shows the total area and production of cereals - mainly: wheat, barley, maize, sorghum, millet and rice - in Arab countries in 1982.

THE PROBLEM OF THE SECURITY OF FOOD SUPPLIES IN THE ARAB WORLD

It is appropriate at this point to evaluate the magnitude and to analyse the economic status of the food problem in the Arab world in order to project scientifically and predict correctly future trends in agricultural production in cereal producing countries.

In 1980, the Arab Organization for Agricultural Development (AOAD) studied the development of strategies and the planning of programmes for food security in the Arab world. The results provide important indicators of the food problems and are summarized below:

1. The food gap (i.e. the difference between requirements and production) in cereals has increased during the 1970s from 6.7 to 15.6 million tons at an annual rate of 13%. In wheat the gap has increased from 5.9 to 11.5 million tons at an annual rate of 10%. This situation arose through many factors, but mainly as a result of a declining rate of expansion in food production and a high rate of increase in demand.

2. While food imports increased in the early 1970s from $2400m to $7400 later in the decade food exports (fruit and fish) declined from $729000 to $254000. Hence there was an annual increase of 20% in the declining total agricultural food-trade balance. Cereals constituted the greatest part of the food gap value, amounting to 35% with wheat forming 25% of that amount. Meat products, sugar, milk products and oils each constituted 13%, 12.7%, 12.7% and 9.5% of the food gap value respectively.

3. While the total cultivated area increased slightly from 31.4m ha in 1970-72 to 34.8m ha in 1977-79, with an annual increase of 1.5%, the population grew during the same period at a rate of 2.83%. Agricultural intensification increased very slightly from 64% to 71% between the same dates. These two factors resulted in the decline of cultivated area per capita from 25 ha to 23 ha in the Arab countries between 1970-72 and 1977-79.

4. No significant efforts were devoted to technological improvement in the agricultural sector during the 1970s. This negligence resulted in the deterioration of productivity per hectare, in contrast with other parts of the world, and hence played a major role in widening the food gap in the Arab region. For example, productivity per hectare of cereals in Arab countries decreased from about 1.1 tons in 1970-72 to 0.976 ton in 1977-79, while it was increasing from 1.772 to 2.109 ton internationally and from 3.458 to about 4.078 ton in the United States during the same period. This indicates that cereal yields in the Arab world were 50% of those obtained internationally and 25% of those in the United States.

5. Cereal production in the Arab countries in general decreased, because of the above factors, from 23.4m tons in 1970-72 to 22.3m tons in 1977-79 with an annual rate of decrease of 0.68%. During the same period, wheat production decreased from 9m tons to 7.9m tons with an annual rate of decrease of 1.84%. At the same time the annual rate of increase in the production of other food commodities was lower than the annual rate of increase in the demand for those commodities. For example, the annual rates of increase in sugar and oils were 2.5% and 2.9% while the annual rates of increase in demand for the two commodities were 6.0% and 7.5% respectively.

6. The intake of food calories per capita in the Arab world increased from 2385 in 1970-71 to 2706 in 1977-79, while the increase in protein consumed was from 66 g/day to 72 g/day. These figures are better than the world average in terms of energy and equal to it in terms of total protein consumed. In terms of animal protein consumed the Arab region average is less than the world average. The increase in calories gained and protein consumed is attributed to:

- the annual rate of population growth;
- the increase in per capita income;
- the adoption of policies aiming at making food available in abundance;

- the subsidisation of food prices;
- the continuous immigration from rural areas to urban centres.

Cereals provide 61% of the calories and 68% of the protein consumed daily and hence they constitute the main food group in all Arab countries.

7. Capital investments allotted to agriculture are meagre (8.5% of total investments). Returns on investments are also minimal because of poor planning and the adoption of traditional practices in agricultural production.

The continuity of the policy aimed at the importation of food resulted in a situation where no true efforts were devoted to agricultural development. The cost of food reached about $49000m during the 1970s and the food gap was increasing annually by $1250m.

FUTURE TRENDS IN AGRICULTURAL PRODUCTION

It becomes obvious from the previous discussions, that the future trends in agricultural production in the Arab world will concentrate on two aspects:

1. Investment in new agricultural projects, especially in the area of food security.
2. Enhancement of productivity per hectare.

New food security projects

More than 150 projects have been identified in the area of food security as a result of the studies conducted by AOAD in 1980, and their implementation will place the Arab world very close to realizing self-sufficiency in major production items by the year 2000. Among these projects 52 were given priority for implementation in the next 5 years. They may be categorized as follows:

a)	cereal and oil production	16 projects
b)	sugar production	10 projects
c)	animal and poultry production	21 projects
d)	fish production	05 projects.

These projects are distributed among 13 Arab countries including Sudan, Morocco, Iraq, Yemen and others. The total investment needed for the execution of the projects was estimated at $4340m (1980). Of this sum $3000m were allotted to cereal and oil crops production alone.

The Arab League which is backing the implementation of these projects has initiated the formation of a working group from the League, the Arab Fund for Economic and Social Development, AOAD, the Arab Authority for Agricultural Investments and Development,

the Arab Company for the Development of Animal Production and representatives from the Arab private sector. Since its establishment in 1984 the working group has gone a long way to promote the execution of 27 projects, some of which are now in existance. One of the major obstacles hindering the execution of the other projects was a lack of up-to-date feasibility studies and funds were required to undertake them. This problem was overcome by the creation of a revolving fund from which the costs of the studies are to be financed and later the money reimbursed from the investment costs of the project concerned.

Increasing production per hectare

If Arab countries are to achieve food sufficiency in the very near future one important factor, among others, that should be given highest priority and the utmost consideration is the increase of production per hectare on Arab farms. One way of doing this is to reduce to a minimum and ultimately eliminate the constraints that cause the very low yields.

In 1982 AOAD investigated the constraints responsible for low yields of the major cereal crops in Sudan, North Yemen, Syria, Iraq, Jordan, Egypt, Tunisia, Algeria and Morocco. The total area under cereals was about 21m ha of which 70% was rainfed (200 - 700mm) and the remainder irrigated. The major crops were wheat, barley, sorghum, millet, maize and rice. Table 3 summarises areas, total production and the average yield in each country. Low yields are claimed to be attributable to low rainfall but several semi-arid regions with similar rainfall patterns have higher average yields.

The main production constraints revealed by this study may be classified as those due to production practices and those arising from a lack of supporting services.

The production practices may be categorized as follows:

- tillage practices
- weeds
- date of planting
- low yielding cultivars
- fertilization
- diseases
- insects, birds and rats
- storage insects.

Constraints arising from the lack of supporting services are:

- poor infrastructure facilities
- small farm size
- lack of agricultural credit for small farmers
- lack of a clear price policy

- shortage of agricultural labour
- poor agricultural research facilities
- inefficient extension service.

The information in Table 4 reveals that land preparation and weeding are ranked the highest among the production practices as causes of low yields in wheat and barley. Poor land preparation reduced the yields of wheat and barley by 39% and 32% and the weeds reduced them by 24% and 27% respectively. Tillage practices reduced the yield of rice, maize, sorghum and millet by 8%, 17%, 14% and 20% while weeds reduced the yields of these crops by 14%, 13%, 22% and 25% respectively. This means that land preparation was ranked 5th, 6th and 2nd in reducing yields of rice, sorghum, millet and maize and weeds were ranked 2nd in the case of rice and millet and 4th in the case of maize and sorghum. The factors ranking highest as constraints to production of millets, sorghum, maize and rice were date of planting, low yielding cultivars, insects, harvest and transportation respectively.

Land preparation. Land preparation, as a major operation for controlling weeds, is characterized in most Arab countries by the following:

1. very low field efficiency in machine utilization;
2. difficulty in obtaining information on suitable primary and secondary tillage equipment;
3. a lack of knowledge of proper ploughing patterns to use in rainfed areas which mainly accounts for soil deterioration and erosion;
4. too few studies on time of ploughing, type of plough and number of cultivations in relation to different crops and soils;
5. no scientific recommendations on the storage of soil moisture. The only operation carried out is the incorporation of crop residues into the soil through shallow harrowing. This operation is popular in western part of the Arab world but in most areas shallow harrowing encourages wind soil erosion;
6. machinery is used for ploughing and harrowing on a large scale in most Arab countries but in some, such as Yemen, Jordan, Algeria and Morocco, the small size of farms restricts the use of machines.

The first ploughing usually commences after the first shower and germination of weed seeds. In countries in the western region, however, it is done immediately after harvesting mainly to incorporate plant residues into the soil. Most farmers are inclined to adopt deep ploughing (20-25 cm), using moldboard ploughs, as a primary operation regardless of the fact that water loss is directly related to the depth of ploughing. Moreover, recent studies have shown that the use of moldboard ploughs should be avoided in arid

and semi-arid zones.

The following points on land preparation require attention.

Primary and secondary tillage operations are done to prepare suitable seedbeds, to restore soil moisture and to eradicate weeds. Applied field research should aim at providing answers to such questions as:

optimum depth of ploughing,
optimum time of ploughing, and
optimum number of times of ploughing.

Answers to these questions and perhaps many more, will help minimize moisture evaporation from the seed zone, increase water absorption capacity of the soil and control wind and water soil erosion. Any new knowledge generated must be transferred to the farmers.

Weed control. Some comments on the problems of weeds in Arab countries are given below:

1. The Arab countries are infested with different varieties of weeds. In general cereal crops are infested with broad-leaf weeds while in the western part of the Arab world cereals are heavily infested with narrow-leaf weeds which cause a 50% reduction in yield.
2. In areas with less than 300 mm rainfall, weeds, which are generally more adapted to drought, compete with the cereal crop for moisture and consequently many cereal fields are left unharvested.
3. In rainfed areas sowing takes place after ploughing to eradicate weeds has been completed. Often this operation takes up to 2 months and thus can cause a delay in the date of planting and the possibility of a considerable reduction in yield.
4. No effective weed control is carried out in the Arab world. A few farmers preform hand or mechanical weeding in small holdings as in northern Yemen. Hand weeding is slow, tedious and expensive. Application of herbicides in most Arab countries is limited. In Algeria, Tunisia and Morocco herbicides are applied to 12 - 15% of the wheat area, while in Egypt, Syria and Jordan herbicides are used in 3% and 5% of the wheat area. Iraq is ranked number one in herbicide application because weeds in 60% of the rice fields are controlled chemically.
5. Most farmers leave weeds to grow in their fields for use as fodder later without realizing the danger that might arise from such a practice. Moreover, farmers adopting the 2-course rotation of cereal - fallow usually do not plough the fallow portion of the land and allow the weeds to grow as pasture. When this happens the weeds consume all the available moisture and the next seasons crop suffers.
6. The Arab world is experiencing a shortage in personnel qualified to provide weed research and extension services.
7. In some Arab countries chemical control is not adopted

because of a lack of herbicides and sprayers or because there is no government agency to carry-out the operation. The unavailability of water within a reasonable distance of the field also restricts the application of herbicides.

8. The prices of herbicides and sprayers are not subsidised in most Arab countries. The only financial support offered by government is the exemption from taxes.

9. The scattered small holdings in most Arab countries restrict aerial spraying of herbicides.

In order to improve weed control practices in the Arab world the factors mentioned above should be corrected and improved. In addition, the following recommendations should be considered.

1. More training should be offered to technical cadres in charge of spraying operations in aspects such as sprayer adjustment, application of the correct dose and methods of application.
2. Integrated weed control programmes should be adopted which include:
   - proper seed bed preparation (at the right time and with the right equipment);
   - planting early germinating seeds;
   - planting clean seeds free from weeds;
   - eradiction weeds in the early stages of plant growth;
   - application of suitable herbicides for the weeds that are there;
   - burning crop residues to destroy weeds and their seeds.

Table 1. Relative importance of agricultural sector in relation to GDP.

Country	Agriculture %		GDP (Millions of $)	
	1982	1960	1982	1960
Jordan	7	N.A.	3500	N.A.
Syria	19	N.A.	15240	890
Iraq	N.A.	17	N.A.	1580
Yemen Democratic	12	N.A.	630	N.A.
Yemen Arab Rep.	26	N.A.	3210	N.A.
U.A. Emirates	N.A.	N.A.	29870	N.A.
Saudi Arabia	1	N.A.	153590	N.A.
Kuwait	1	N.A.	20060	N.A.
Tunisia	15	24	7090	770
Algeria	6	16	44930	2740
Libya	2	N.A.	38360	310
Egypt	20	30	2640	3880
Morocco	18	23	1470	2040
Sudan	36	N.A.	9290	1160
Somalia	N.A.	71	N.A.	160
Mauritania	29	44	640	95

Source: AOAD Year book of Agricultural Statistics, Vol. 4 - 1984

Table 2. Total area and production of cereals (area x 1000 ha; production x 1000 tonnes).

Country	1973 - 1975 (AV.)		1980		1981		1982	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Jordan	261	135	186	178	149	73	153	75
Syria	2484	1748	2699	3880	2640	3554	2847	2280
Iraq	2221	1645	2422	1886	345	2029	2430	2059
Yemen (S)	25	27	29	28	38	35	29	30
Yemen (N)	1276	1049	822	798	849	812	837	760
Saudia	319	234	453	266	274	294	286	507
Tunisia	1521	1077	1311	1198	1445	1266	1196	1302
Algeria	3126	1919	3161	2418	2836	1832	2568	2064
Libya	491	242	555	215	450	247	280	285
Egypt	1972	7789	2000	8195	2009	8238	2027	8522
Morocco	4412	3918	4417	4505	4383	2122	4281	4908
Sudan	3478	2182	3943	2280	4297	3837	5336	3976
Somalia	463	234	572	267	720	383	755	405
Mauritania	-	39	174	53	211	86	151	58
Total	22,049	22,238	22,744	26,167	22,646	24,808	23,176	27,231

Table 3. Area, production and yields of cereals in nine Arab countries 1976-1980

Country	Area x 1000 ha	Production x 1000 tonne	Yield kg/ha
Jordan	172	97	564
Algeria	3179	2416	760
Sudan	4382	2719	620
Iraq	2025	1732	855
Morocco	4320	3833	981
Yemen (N)	994	869	874
Tunisia	1531	994	649
Syria	2630	2641	1004
Egypt	1981	7914	3995
Total	21,214	23,215	1,094

Source: Assessment of constraints in Cereal production in Arab countries. A.O.A.D. August 1982

Table 4. Summary of the percentage reduction in grain yield attributed to the main constraints of production practices for the major cereal crops.

Constraints	Wheat %	Barley %	Rice %	Maize %	Sorghum %	Millet %
Tillage practices	39	32	8	17	14	20
Date planting & seeding	18	18	4	12	21	27
High yielding cultivars	14	22	4	15	25	27
Fertilizer use	21	20	11	11	24	10
Harvest & transport	8	4	19	5	5	5
Weeds	24	27	14	13	22	25
Diseases	6	6	10	5	10	7
Insects birds & rats	16	14	14	27	30	12
Storage insects	10	12	5	5	14	12

Source: Assessment of constraints in Cereal Production in Arab countries Arab Organization for Agricultural Development, August 1984

WEED MANAGEMENT IN DRYLAND CEREALS PRODUCTION WITH SPECIAL REFERENCE TO THE NEAR EAST

S.T. Kukula
ICARDA, P O Box 5466, Aleppo, Syria

Summary In regions with very low rainfall, weeds compete with crops mainly for moisture which is the limiting factor for growth and plant development. Although some modern technology has become part of new farming methods of the Near East countries, modern weed control is still lagging behind.

Weed control should be considered as an integral part of agronomic practices such as tillage, sowing time, proper seed rate, row spacing and fertilizer application. Some of these factors can markedly influence weed infestation and can strongly interact with weed control. Only when weeds are properly controlled can economical responses to the package of improved agronomic practices be clearly observed by farmers.

However intensively a soil is ploughed and worked, weeds emerge and compete with crops. Long term weed control should involve an integrated system of cultural practices, rotation and herbicides use.

INTRODUCTION

The weed problem has become one of the most important factors in cereal production in the Near East since early winter planting has been recommended for higher yields. Early sown crops germinate and grow slowly while weeds, which are more resistant to poorer conditions (lower temperature and soil moisture stress) grow faster and effectively compete with plants for the growth-limiting factors. A very crude survey of the important weed species present in ICARDA region was conducted in 1977-80. Some of the species predominant in this region are Sinapis arvensis, Vaccaria pyramidata, Cephalaria syriaca, Galium tricorne, Avena sterilis and Phalaris brachystachys. All these weeds can cause large losses in crop yields.

Traditional weed control has been widely based on manual weed pulling, on hoeing or on tractor-drawn hoeing machines. But traditional weeding is not sufficiently effective for a number of reasons. These include the following:

1. Weeds are usually destroyed when they have already grown i.e. when they have already consumed important nutrients and moisture to the disadvantage of the crops.
2. Two or three hoeings per growing period are usually necessary. These are often done when other farming operations permit and not at the proper time.
3. Mechnical weed control can only remove weeds from between but not within the rows. It is particularly in the root zone that crop plants are affected by competing weeds.
4. All mechanical and manual operations are likely to damage the roots and even the shoots of crops.
5. Weed problems often get out of control when mechanical and manual methods fail to keep up with the rapid weed growth. This happens, for instance, when certain conditions do not permit machines onto the fields for some length of time.

In the Near East region, hand-pulling of weeds has been commonly used at a very late stage of growth and development, when weeds are flowering and have nearly completed having any competitive effect on the crop. Late weeding does not help to increase crop production but yields a good quantity of fodder to feed livestock. However, the economic value of this operation is questionable. Likewise, it could be useful if weeding were done thoroughly to prevent weed seed dispersal and at least prevent the reproduction of annual weeds. In practice, however, this is not the case, since weeding is done over an extended period of time in order to gather the daily fodder requirement. Also, undesirable weed species are often left within the crop. Early weeding with a handhoe, when weeds are still small, does increase crop yield. However, some weeds can still escape and have time to establish and produce seeds. Naturally two weedings could help to solve this problem, but in many cases this requires too much labour.

Many of the farmer's practices, including such basic operations as ploughing and crop rotations, are largely dictated by the problem of controlling weeds. Changing from crop rotation to monoculture has increased at least partly the wild oat problem. The need for ploughing to control weeds (especially perennials) also imposes constraints on the timing of the farmer's operations, increases expenses and leads to further reduction in efficiency and productivity. Minimum cultivation with the aid of herbicides is already having a considerable impact in some countries. The spacing of crops in relatively wide rows is another cultural practice dictated by weeds to facilitate their mechanical removal. However, the yields of cereals have been or might be substantially increased by the use of closer row spacing. Such a technique, in turn, can only be successful in the absence of weeds. This, in effect means the use of herbicides. There is considerable scope for the increased use of herbicides to contribute

to improved productivity in various indirect ways of this The introduction of herbicides to provide at least partia control of weeds and the improvement in cultural control r are key factors for increases in crop production.

Crop losses due to weed competition

Crop losses from weeds vary greatly from country to cou from place to place in any given country. Approximate est have been made in the countries covered by ICARDA's resear activities and indicate a percentage loss in cereals varyi 15 to 20 percent. These are only direct losses based on t reduction in quantity of the harvested crop.

On the other hand, there is a considerable amount of that omitting weed control from the "package" of improved mic practices for higher yields will cause the loss of all fits given by the rest of the "package". In other words, weed control the added soil moisture and fertility may sim into producing more weeds rather than into increased crop

Cereals are among the more tolerant crops to weed com However, as already indicated, the loss of yield due to wee been estimated in the Near East at an average of about 15 1 percent. The level of competition with weeds varies greatl cereal species as well. For example, barley competes much successfully with weeds than breadwheat and durum or tritic which are all similar in performance. Also, differences ar evident among varieties of the same species. Usually the s varieties are more sensitive to weeds than the taller ones. other morphological characteristics might also indicate dif in weed competition.

This kind of cereal-weed competition should continue t extensively investigated and, eventually exploited in pract

Cultural practices

Cultural practices used for weed control do not show t effective weed control although some of these practices (i. ploughing, seeding rate, row spacing) reduce weed growth an increase yield.

The effect of good weed control on yield under high so fertility conditions is better than at low soil fertility. Likewise, the benefit in absolute yield increases is much g under higher rainfall than under lower rainfall although the relative increase is in favour of low rainfall. Good weed control is much more necessary in a continuous cropping rota than with fallow if this is kept clean by mechanical cultiva Of course, the latter is not a solution for an intensive cro

production system.

Scientific evidence gathered in the last decade suggests that there are a number of ways in which ploughing aids plant growth, its major effect being that of controlling weeds.

Soil characteristics and other environmental factors are an important consideration in the selection of an appropriate tillage system. Research on "zero" tillage has been intensively carried out in the tropics with some work also done in the dry regions of the Near East.

In a trial conducted in Syria from 1979 to 1983 (Table 1), tillage methods had a pronounced effect on weed growth, with consistently higher weed dry matter production under "zero" tillage than under conventional tillage. Timing of sowing and of tillage, where applicable, also had an important effect, particularly under the conventional tillage systems where high levels of weed infestations resulted when both operations were completed before the rains. This is also reflected in the results from other experiments where it was shown that a pre-sowing cultivation, after weeds had been germinated by early rains, resulted in a substantial decrease in weed infestation.

Also, a very different composition of weed flora resulted in the plots subjected to different tillage treatments.

As already indicated, wheat is usually a poorer weed competitor than barley. Farmers can go a long way towards reducing their weed problem by ensuring good crop establishment and rapid early growth of their wheat crop.

Seed rate and row spacing are also important factors affecting stand establishment, weed infestation and moisture utilization in dryland farming (Bakdash, 1983; Dhiman and Kairon, 1983; Photiades and Hadjichristodoulou, 1984). The main effect of seed rate and of row spacing has been studied in northern Syria during the period 1982/83 and 1983/84 (Table 2).

Table 1. Main effects of tillage on weed dry matter and wheat yields in three-year trial at Tel Hadya - Syria

	1979		1981		1983	
	Rainfall 426 (mm)		Rainfall 338 (mm)		Rainfall 230 (mm)	
	Weed dry matter (kg/ha)	Wheat yield (kg/ha)	Weed dry matter (kg/ha)	Wheat yield (kg/ha)	Weed dry matter (kg/ha)	Wheat yield (kg/ha)
Conventional Tillage						
Early timing	1621	1970	482	1479	807	429
Medium timing	985	2393	332	1702	231	653
Late timing	929	1741	340	1764	251	466
Zero Tillage						
Early timing	1709	1243	989	569	970	156
Late timing	1803	848	788	693	530	621
L S D (0.05)	741	353	188	235	209	178

Table 2. Main effect of seed rate and row spacing on weed infestation and wheat yields in northern Syria

	Weeds (TDW)[1] (kg/ha)	Grain yield (kg/ha)
Seed rate (kg/ha)		
30	1137	1108
90	229	1382
150	64	1645
L S D (0.05)	724	364
Row spacing (cm)		
10	444	1605
18	462	1366
25	525	1162
L S D (0.05)	379	373

[1]Total dry weight

Both seed rate and row spacing had significant effects on yields with the highest grain yields resulting from the plots having the lowest weed infestation level. The competitive effect of a high seed rate was further demonstrated in other trials where no weed control was compared with herbicides use (Table 3). It was clear that the effect of seeding rate was greatest where no weed control was exercised.

Table 3. Effect of seeding rate on response of wheat yields to chemical weed control in Syria

Seeding rate (kg/ha)	Wheat yields: No weed control (kg/ha)	Wheat yields: Herbicide control (kg/ha)	Increase in yield due to herbicides (%)
30	980	1360	39
90	1780	1970	11
150	1980	2120	7

It should be noted that farmers are unlikely to use low seed rates such as those tested in these experiments. In fact, their common practice of sowing is around 100 kg/ha of seed and this seems quite satisfactory. However, very poor crop establishment, equal to low seeding rate, can often be observed in farmers' fields due to a number of different factors. Options for row spacing are currently limited by the available machinery. Hand sowing over ridges produces a row spacing of about 50 cm, while the locally produced drill is fixed at approximately 18 cm. Nevertheless, if farmers are unable to control weeds, either through late sowing or through the use of herbicides, then rapid crop establishment through good seed bed preparation and high seed rate will enable the wheat crop to compete with weeds and some yield advantage will be obtained. However, it is also equally obvious from the results of several seasons work that the yield advantage and the economics of herbicide use on early sown wheat make this the preferred option. Early sowing (before the rains) increases yields, but it also requires more weed control. Late sowing (after the rains start) allows weeds to be controlled by preplanting tillage operations, but the resulting yields are often substantially smaller than with early sowing.

It should be noted that weed control has to be considered always as a part of cereals agronomy since strong interaction with many agronomic and environmental factors always exist. In order to identify the most significant factors leading to increases of cereals production in the Near East, a number of different variables were tested in northern Syria.

The variables were: Date of sowing (D), Late (L) vs Early (E); No Nitrogen (N-) vs (N + at 60 kg/ha); no Phosphorus and Nitrogen (NP-) vs NP+ (at 80 kg N + 60 kg P_2O_5/ha); no Weed Control (W-) vs Weed Control (W+ bromoxynil + diclofop methyl). The results are presented in Table 4.

From the data it appeared that early sowing resulted in greater weed dry matter production (about 95 per cent higher) than late eowing where no weed control was used. No eignificant differencee in grain yield occurred at early and late date of sowing in the absence of weed control. However, when weed control wae ueed, the yield of the herbicide-treated plots was significantly higher in the early sown crop.

Ae expected, fertilizers (Nitrogen and Nitrogen plue Phoephorus) increased weed growth and produced higher yields when the weed were controlled. The resulte of theee triale eupport obeervations that the current farmer practice of controlling weeds through late sowing is reasonably effective. However, it is also clear that a combination of early sowing, fertilizer and herbicides can produce substantial increases in wheat yields in the Near East.

Table 4. The effect of date of sowing, fertilizers and weed control on the growth of weeds and the yield of wheat.

	Weeds (TDW)[1] (kg/ha)		Grain yield (kg/ha)	
D x W	DL	DE	DL	DE
No weed control	1420	2780**	1860	1750*
Weed control	220	380	1600	2280*
N x W	N-	N+	N-	N+
No weed control	1670	2530*	830	900
Weed control	250	340	1970	2050
NP x W	NP-	NP+	NP-	NP+
No weed control	687	914	1200	1451*
Weed control	71	97	1377	1752*

*Significant at 1 percent level

**Significant at 5 percent level

[1]TDW = Total Dry Weight

Chemical Weed Control

The use of herbicides is becoming a necessary practice for reducing production costs and maximizing yields. It is also a necessary "insurance" against yield reductions caused by early weed competition. There are a number of suitable pre- and post-emergence herbicides for weed control in cereals, especially for broadleaf weeds. Some of these compounds, or their combinations, are known to increase yield as much as, or even more than, twice that obtainable by handweeding. This, of course, if chemicals are applied at the proper time and early enough to eliminate or limit weed competition (Table 5). It should also be recognized that there is still a great need for research on pre-emergence application of herbicides for the total suppression of weeds at early stages of cereal growth.

It should also be noted that late chemical control of broadleaf weeds helps very little in increasing yield. Certain grass weeds, e.g. Avena sterilis, Phalaris sp. which are becoming a serious problem in cereals in the Near East, can be controlled through proper rotation systems and the use of selective herbicides in the rotation.

Table 5. Effect of chemical weed control on grain and straw yields of wheat in three locations in northwest Syria[1]

	Jindeeres 417 mm	Kafr Antoon 341 mm	Tel Hadya 323 mm
No weed control			
Grain yield (t/ha)	1.39	1.68	1.09
Straw yield (t/ha)	1.46	2.59	2.19
Chemical weed control[2]			
Grain yield (t/ha)	2.27	2.09	1.70
Straw yield (t/ha)	3.27	3.12	1.93

[1]Source: ICARDA, 1983 - Research Highlights

[2]Brominal Plus

Economic returns from weed control are also very attractive. The cost of herbicide application in the trial reported in Table 5 was about 110 Syrian lira (SL)/ha, but the increase in value of the grain yield (based on the value of 1.20 SL/kg for bread and durum wheat) was 1060 SL/ha at Jindeeres, 730 SL/ha at Tel Hadya and 500 SL/ha at Kafr Antoon.

This trial excludes the increased harvesting costs. However, this is more than compensated for by the increased value of the straw and the additional benefits of reduced weeds in the succeeding crops.

GENERAL CONCLUSION

This review has mainly focused on wheat production. However, barley is the second most widely grown cereal in the Near East. Barley is predominant in the drier areas (below 350 mm rainfall), Hence the weed problem is not the most important factor limiting its yield increase. Also, barley is an excellent competitor with weeds, therefore chemical control is usually not necessary. Chemical control could be only justifiable in a specific environment with very high wsed infestation levels.

While there are a number of suitable herbicides for weed control in cereals, especially for broadlsaf weeds, there is still a great need for insxpensive and effective herbicides to control weed grasses, especially: wild oats (Avena sterilis) and canary grass (Phalaris brachystachys), both of which are becoming very ssrious in the region.

Early post-emergence herbicides are effective but they do not control weeds during the whole growing season.

There is also need for an integratsd weed control approach. This is the development of a management system which could economically combine two or more wesd control methods at low input levels in ordsr to reduce weed competition in a given cropping system. In such situations, integrated wsed control would involve tillage and cultural practices for one crop in the rotation and herbicides for ths other crop. This would greatly reduce weed infestation hazards for following crops.

Application of selective herbicides for specific weeds e.g. grasses in legumes, can result in a significant reduction or elimination of these weeds in cereals which are more sensitive to grass killers and usually follow the legumes in the crop rotation.

Early sowing and fertilizer application are the key factors for increasing production in the Near East. But this is only effective when weeds are properly controlled.

Efforts towards introducing chemical weed control in practice should be undertaken by extension services under the supervision of weed specialists.

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IMPROVED WEED MANAGEMENT IN VEGETABLE PRODUCTION*

A.R. Saghir
Professor of Weed Science, American University of Beirut
Bierut, Lebanon

INTRODUCTION

Vegetable production is a very specialized agricultural operation, with crops grown intensively under varying conditions of climate and soil in the Near East region. In Lebanon vegetables constitute an important segment of the total agricultural production of the country. Tomato, cucumber, potato, onion, lettuce and eggplant are some of the major vegetables grown in Lebanon and neighbouring countries.

In the Arabian Peninsula, including the Kingdom of Saudi Arabia and the Gulf States, there is a great diversity in vegetable production with crops grown intensively in oases under palm plantations, or in newly developed farms where water resources have been tapped. Some vegetable crops, like tomato and cucumbers, are widely grown in plastic houses in most countries of the region.

CROP LOSSES AND WEED PROBLEMS

Weeds cause serious problems in most areas planted to vegetable crops. Losses due to weeds can easily mean the difference between profit and loss in vegetable production. Weed competition studies have shown that a 15% weed stand remaining for the first five weeks after planting carrots reduced the yield by 78%, whereas a 50% weed stand reduced the produce by 91%. In onions leaving a 15% weed stand for the first six weeks reduced the yield by 86% and a 50% weed stand caused a reduction of 91%. In Lebanon, Saghir and Markoulis (1974) reported that maximum competition between weeds and potato occurred 9-12 weeks after planting.

Some of the major broadleaf weeds infesting vegetable crops are: *Amaranthus retroflexus*, *A.graecizans*, *Chenopodium album*, *C.murale*, *Convolvulus arvensis*, *Lactuca seriola*, *Melilotus indica* and *Portulaca oleracea*. Grass weeds include *Cynodon dactylon*, *Echinochloa colona*, *Eragrostis berrelieri* and *Setaria verticillata*. In addition, sedges (*Cyperus* spp.) are very common in the Near East region.

* (Contribution from the Faculty of Agricultural and Food Sciences, American University of Beirut, Journal No. 646 B, and the Arab Society for Plant Production).

A very serious problem which infests tomato and potato fields in the region is the noxious root parasite Orobanche spp (broomrapes). Under heavy infestation with this parasitic weed crops are completely destroyed and broomrape seeds which are shed into the soil may prevent the economic production of solanaceous crops in the infested areas for many years to come. Some Cuscuta spp (dodder) infestations have been observed in patches in association with several vegetable crops grown in the Near East region. These include tomato, onion and other vegetables which are seriously affected by dodder if it is not kept confined and under control. Since Cuscuta parasitizes weeds before starting to twine on most vegetable crops, it becomes extremely important to implement an effective weed management program in these crops.

WEED MANAGEMENT PRACTICES

Most farmers in the Near East region use handweeding or hoeing, since vegetable crops are either interplanted or intermixed in the same row or bed in small plots. However, with the development of new agricultural projects in the Arabian Peninsula and other Middle East countries, the production of speciality vegetables under drip irrigation makes chemical weed control more attractive.

The availability of more selective herbicides enables the farmers to control weeds far more efficiently and with less human effort than in the past, However, herbicides which have given excellent results in Europe, the United States or Japan may injure the crop or fail to control weeds in the Near East region. Hence it is essential to conduct weed control experiments under the local conditions before giving recommendations to growers.

RESEARCH ON WEED CONTROL IN VEGETABLE CROPS

Weed research in vegetable crops is carried out at the American University of Beirut as a component of an overall project covering all aspects of weed control studies on horticultural and agricultural crops. This program was initiated in 1959 and, since then, several studies have been conducted on the influence of herbicides and other chemicals on the yield, horticultural characteristics and quality of several vegetable crops. Literature reporting these studies is cited in the list of references.

Studies on vegetables crops were conducted either in the greenhouse or under field conditions in Lebanon, Jordan or in the United States during Sabbatical leaves of the author. The crops included onion, garlic, tomato, potato, eggplant, cucumber, cauliflower and asparagus. In addition to work on the effect of herbicides on the

yield and quality of vegetables, some studies were made on the effect of activated carbon on soil-applied herbicides (Lange et al., 1974; Lange et al., 1982), and the effect of waxes on the activity of post-emergence herbicides on several vegetable crops (Lange and Saghir, 1981a; Lange and Saghir, 1981c).

During the last 15 years, studies concentrated on the biology and control of Orobanche (broomrapes), a serious parasite on several solonaceous and legume crops. In addition to studies on the efficacy of herbicides different chemicals and synthetic germination stimulants were tested for broomrape control in tomato. A multi-disciplinary experiment was conducted on the response of different tomato cultivars to the root-knot nematode, tomato yellow leaf curl virus and Orobanche in Jordan (Abu-Garbieh et al., 1978). Another parasite which was studied was Cuscuta spp. (dodder). Experiments were conducted on the post-emergence control of attached dodder in tomato (Lange and Saghir, 1982).

THE FUTURE

Improved weed management in vegetable production in the Near East should stress practices which benefit small scale farmers. This may be done by improving weed control techniques to match agricultural operations practised by these farmers; such as sowing and transplanting methods, thinning, tillage practices, irrigation, fertilizer application, pest control and harvesting techniques. This kind of interaction between cultural practices and weed control technology should evolve as a result of continuous and meticulous research on the national level, coupled with efficient and effective training and extension programs. Such efforts may concentrate on the following topics:

1. Screening of new selective herbicides locally - on the national level - taking into consideration the composition of the local weed flora, cultivars of vegetable crops grown, weather and soil conditions, ecological and public health aspects.
2. Studies should be made on the interaction between herbicides and the use of activated charcoal, waxes, soil stabilizers, plastic covering and other techniques used in vegetable growing.
3. Work should be conducted on the use of herbicide - coated seeds for vegetable production in protected environments.
4. Research should be made on the use of 'herbigation' techniques especially the application of soil-applied herbicides with drip irrigation in plastic houses.
5. Since two or more vegetable crops are grown on the same field in one season, it is important to study the residual effects of herbicides on subsequent crops.
6. The use of the new selective grass herbicides in broadleaved

vegetablee should be of great interest to small farmers in the Near East region, eince theee are applied poet-emergence and will not cause injury like soil-applied chemicals.

7. In the case of intercropping, which is practieed by farmers in the region, the use of the stale bed technique is recommendsd, where paraquat or glyphosate is applied on emerged annual or perennial weede, reepectively, prior to planting the vegetable crops.

8. Work should be continued on eeeking effective and economic control msasures for the parasitic wssd; Orobanchs, Cuscuta and Striga.

In addition to the control measures suggeeted it ie neceeeary to etrees the importance of preventive methods of wesd control through the implementation of etrict quarantine regulations pertaining to seed purity and fresdom from parasitic and other noxious weeds.

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ALTERATION OF TRADITIONAL WHEAT CROPPING SYSTEMS IN NORTH EAST SYRIA AND CHANGES IN WEED PROBLEMS

H.G. Jansen and A.E. Jansen[1]
Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), FB. 152,
Postfach 5180, D-6236 Eschborn 1, Germany
and

Universitat Hohenheim,
Institut fur Pflanzenproduktion in den Tropen und Subtropen
Postfach 700562, D-7000 Stuttgart 70, Germany

Summary. Efforts are being made to change the old cropping system based on wheat-fallow to meet the need for raising agricultural production in Syria. One way to achieve this is to increase yield by the introduction of high yielding varieties, fertilizers and weed control. Another way is to substitute the fallow with new crops in rotation with wheat. A study was conducted to monitor changes in the traditional cropping system as well as in newly introduced rotations. The weed community in the Hasakeh Province represents the result of long-term influences by the wheat-fallow rotation on the local weed flora.

Fallow cultivation and seed bed preparation have so far been the only measures of weed control. In this way it has been possible to keep weed infestation in the crop more or less at the same level. A study on the application of phenoxy herbicides over the past 12 years in the old cropping system showed no changes in the weed community. Under practical conditions, chemical weed control did not very often result in yield increases. Since new rotations have so far been applied to a minor extent only and have not lasted for a sufficiently long period, the weed community has not shown any changes. However, especially with the more frequent cropping of cereals, and with the use of phenoxy-herbicides, grass weeds are expected to become more important in the future.

Any thorough study of plant communities leads to the observation that species' composition show certain responses to their environment. A plant community is considered to depend upon five factors or factor-complexes (Mueller-Dombois and Ellenberg, 1974):

- the flora of the area;
- the ability of a given plant species to reach the habitat;
- the ecological properties of the plant species to establish

itself in the habitat and to compete with other plants;
- the habitat as a whole being the summation of all the environmental factors;
- the time elapsed following any historical event that initiated vegetation invasion or a change of one habitat factor.

These causes of community formation, arising from vegetation ecology, are also fully valid in weed science. The quality and quantity of a weed community are decisively influenced by all habitat factors, including the cropping practices (Koch, 1980). The development of a weed community with the introduction of irrigated agriculture has recently been studied by Jansen and Koch (1984) in the Savannah area of the Sudan. Already, five years after the establishment of a new irrigation project, the most important weed species are the same as those common in older projects with comparable production systems.

From the fact that plant communities demonstrate certain habitat factors, it follows that they must also react to changes in these factors. The reactions happen through alterations in the species-composition or through a change in the entire weed community (Wilmanns, 1973).

The influence of different components of cropping systems on the type and intensities of weed infestations has been evaluated by Koch et al., (1982). Besides direct control measures, soil cultivation and seed bed preparation, weeds are mostly affected by nutrient supply and soil pH.

From any analysis of factors influencing the development of weeds in a cropping system, it should be possible to predict the reaction of the weed flora to any change within the system (Koch and Walter, 1983). On the other hand, weeds and available methods may also affect and determine certain components in the system. Therefore, an isolated consideration of weeds and weed control is not possible and a integrated approach is necessary.

Hardly any data concerning such aspects were available for the Near East region. To secure this information, cooperation was initiated between a project for "Plant Protection by Aviation" within the framework of Syrian German Technical Cooperation and the University of Hohenheim. The study was limited to the traditional wheat-fallow rotation in north-east Syria and was aimed at determining the importance of the weed flora in the traditional cropping system as well as the influence of a modification to this rotation, by the introduction of new cropping practices.

MATERIAL AND METHODS

The investigation was carried out in 1980/81 and 1981/82 in the province of Hasakeh, one of the major wheat production areas of Syria. The climate here is semi-arid and Mediterranean but with some continental influence. Annual precipitation, the most important fact influencing production, amounts to 465 mm in the city of Kamischli, close to the Turkish border, and decreases progressively in a south-westerly direction to as low as 270 mm at Hasakeh, about 70 km south.

The province may be sub-divided into five agricultural zones, on the basis of precipitation. Only in zones 1 and 2, with more than 250 mm annual rainfall, is wheat (and/or barley) traditionally grown in rotation with fallow. Here, both fertilizer and weed control are commonly used. In the other zones, agriculture is restricted to barley cultivation or pasture.

Especially in zone 1, annual precipitation is sufficient to allow continuous cropping. Here, the aim of the Syrian government is to intensify agricultural production with the introduction of new rotations, such as wheat-wheat-fallow and wheat-lentil (or other leguminous crops).

In the wheat-fallow system, fallow is cultivated with a disc-harrow up to four times. The main purpose of this operation is to increase water storage, but weed control is also an important objective. Wheat is sown at the rate of 125 kg/ha in October/November and lentils in November/December.

Some 20 years ago, state farms and several private farmers started using herbicides in wheat. Until recently, only formulations of 2,4-D or other Phenoxys were used. Aerial application was important from the very beginning. Since 1982, only aircraft belonging to the Ministry of Agriculture have been used to treat 23 000 ha out of the 130 000 ha existing in the Kamischli District.

The problem that arose was to determine the effect of the new rotations and long-term application of 2,4-D on weeds. Fields following the new rotations were chosen at random and data were collected on rotation, cultivation and use of fertilizers and herbicides. The abundance of weed species was determined by counting in 15 x 1 m^2 in each field, or it was estimated by the Braun-Blanquet scale (1964, cited in Mueller-Dombois and Ellenberg, 1974). The selection of fields for sampling was made on the basis of comparable production practices, substitution of fallow by other crops in part of the fields, and different numbers of past herbicide applications.

Determinations were made of the frequency of each weed species

within the sample of one field and the frequency of the same species over all samples. Using numerical methods and computer facilities, the occurrence of each weed species was related to particular environmental or production factors (such as the number of herbicide applications) through mean frequency values. In addition, a cluster analysis was used for the whole data set in order to detect, with this multi-variate classification method, more complex relationships within the weed community. Only part of the results are presented here (for further details see Jansen, 1986).

Apart from floristic investigations, the result of chemical weed control and some of its economic relevance was assessed in the form of "half-field" comparisons (see Koch et al., 1982). Fields to be sprayed by air were chosen by the Syrian Agricultural Authorities according to weed density. The threshold used was 6 plants/m^2 of broad-leaved weeds (e.g. Cephalaria syriaca, Galium tricornutum, Isatis lusitanica, Lisaea syriaca, Vaccaria pyramidata). The normal application rate of 2,4-D was 1260g a.i./ha.

Twelve fields were selected in different areas including those with high weed densities and those approaching the above threshold-level. An area of about 1000 m^2 was earmarked for not being sprayed. Plots of 150 m^2 of both untreated and treated parts of a field were then selected and marked for harvest. Weed species and their density were determined at time of herbicide application. The results of weed control were estimated about six weeks later and 20 m^2 were harvested separately by hand in each of the above 150 m^2 plots for wheat yield determinations.

RESULTS

Weed flora

A total of 236 vegetation samples were collected and more than 240 species, belonging to 42 families, could be identified. The most common plant species (at least 20 percent frequency), referring to 148 samples are listed in Table 1. The majority of species were more common in areas with higher annual rainfall or showed no relation to any climatic factor. Most species were annuals and germinated in autumn or early winter.

Table 1. Most common plant species in the Hasakeh Province, arranged according to frequency.

Avena spp.	85	Adonis spp.	43
Coronilla scorpioides	80	Vicia michauxii	40
Lathyrus inconspicuus	80	Echinaria capitata	39
Lolium spp.	78	Tordylium aegyptiacum	38
Cirsium sp.	72	Scorpiurus muricatus	37
Galium tricornutum	69	Gladiolus aleppicus	36
Cephalaria syriaca	68	Ceratocephalus falcatus	34
Convolvulus arvensis	66	Eremopoa persica	34
Malcolmia crenulata	65	Actinolema eryngioides	33
Euphorbia falcata	64	Filago sp.	32
Lisaea syriaca	63	Bellevalia longipes	31
Geranium tuberosum	59	Campanula strigosa	31
Hordeum murinum	57	Euphorbia aleppica	31
Caucalis tenella	56	Hippocrepis unisiliquosa	30
Convolvulus althaeoides	53	Anagallis foemina	27
Bunium elegans	52	Valerianella kotschyi	26
Phalaris spp.	52	Pisum sativum	26
Vaccaria pyramidata	52	Lallemantia iberica	25
Vicia sativa	52	Ziziphora capitata	25
Allium vineale	51	Euphorbia peplus	24
Dracunculus crassipes	49	Allium spp.	24
Hypericum sp.	49	Aristolochia maurorum	24
Ranunculus arvensis	49	Zoegea leptaurea	24
Centaurea spp.	48	Medicago rotata	21
Vicia narbonensis	48	Lathyrus gorgonii	20
Isatis lusitanica	47	Astragalus cruciatus	20
Cynodon dactylon	44	Malva sp.	20
Papaver spp.	43	Veronica polita	20
Silene conoidea	43		

The list contains species with a wide distribution in the whole Mediterranean area (such as Avena sterilis, Coronilla scorpioides, Lolium rigidum and Galium tricornutum) or species confined to the Near East (such as Lathyrus inconspicuus, Cephalaria syriaca, Malcolmia crenulata and Lisaea syriaca) (Holm et al., 1979). Among weeds common in Iraq and the Middle East, this study identified Cirsium acarna, Cephalaria syriaca, Convolvulus arvensis, Isatis spp., Avena spp., and Phalaris spp., (Hussain and Kasim, 1976; Saghir, 1977). Weeds described from wheat fields in Iran also showed high similarity to those presented here (Hubl and Holzner, 1982).

No substantial differences in weed species (composition and frequency) were observed between wheat fields and fallow. In general, annual winter weeds were more abundant in wheat and, to a

lesser extent, in fallow as compared to lentil. The weed composition in lentil fields, however, differed considerably. The species present in lentil fields were those that germinated in late winter/early spring only. Also, some perennials such as Convolvulus spp. or Cynodon dactylon were more frequent in lentil fields.

Table 2. Common weed species in wheat, fallow and lentil

Species with relatively high frequency in only one crop

Wheat	Galium tricornutum
	Isatis lusitanica
	Lisaea syriaca
	Vaccaria pyramidata
Fallow	Caucalis tenella
	Coronilla scorpioides
	Lolium spp.
Lentil	Cirsium sp.
	Convolvulus althaeoides
	Convolvulus arvensis
	Cynodon dactylon
	Euphorbia peplus

Species with relatively high frequency in wheat and fallow

Allium vineale
Bunium elegans
Lathyrus inconspicuus
Malcolmia crenulata
Phalaris spp.
Ranunculus arvensis
Vicia sativa

Species with similar frequency in all three crops

Avena spp.
Euphorbia falcata
Geranium tuberosum

Effects of rotation

All results reported here refer to a relatively limited number of fields sampled during the rather short period of this investigation. Sampling was conducted in February-April during 1980-1982.

In the traditional wheat-fallow rotation, the level of weed infestation in wheat generally followed the same trend in the four fields tested (solid lines) (Fig.1a) and appeared to be independent of the number of weeds in the crop before fallowing. With the exception of two fields (not shown in Fig.1a), an overall decrease in the number of weeds was detectable.

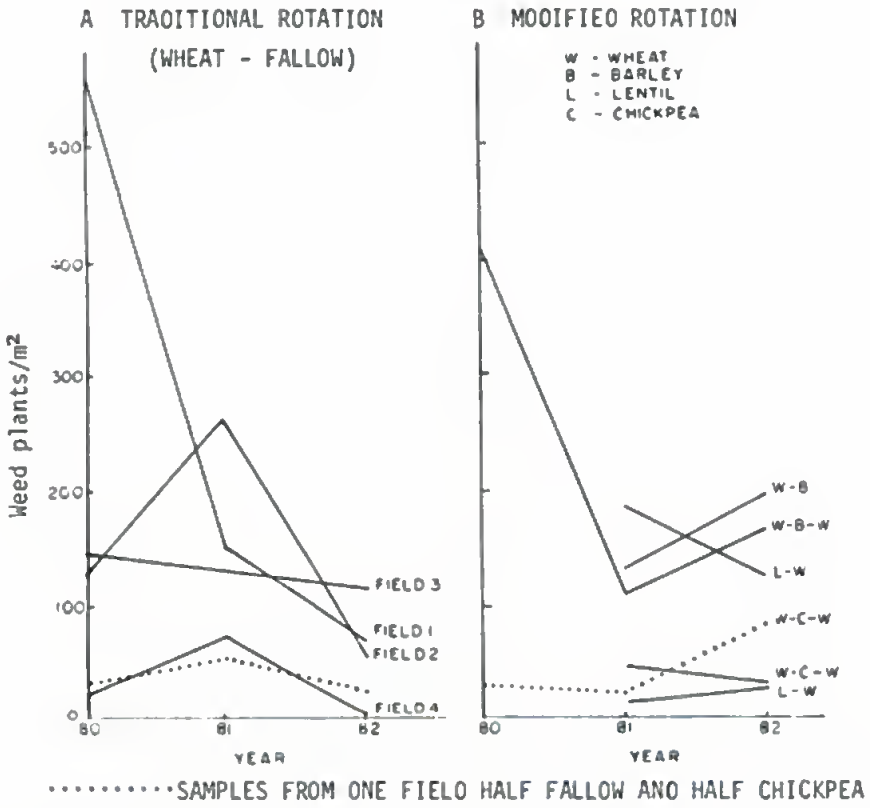

Fig.1. Weed density in three consecutive years in fields subjected to different rotations.

This same trend appears also with more intensive cropping systems, i.e. rotations of wheat with barley, lentils or chickpeas (Fig.1b). In the case of repeated cropping of cereals (wheat and barley), rather divergent courses of weed densities were observed since the number of weeds seemed to increase at higher levels of infestation in 1982.

Lentil fields generally had a rather low weed infestation. In the fields studied, the groundcover of all weeds hardly exceeded 5 percent. This situation proved somewhat different in the less dense crop of chickpeas. In one example, in the same field one half was left fallow and the other half planted with chickpeas. Weed density was lower in wheat after fallow than in wheat after a cropping with chickpea (compare Figs.1a and 1b dotted lines).

Long-term effect of herbicide application

Only a small proportion of wheat fields in the Hasakeh Province are treated with herbicides. At the end of this investigation, data were collected on weeds present in fields which had never received any herbicide, fields which had only one application in the previous wheat crop (i.e. two years before sampling),

and fields which had received up to six herbicide applications in the wheat crop during the preceding 12 years.

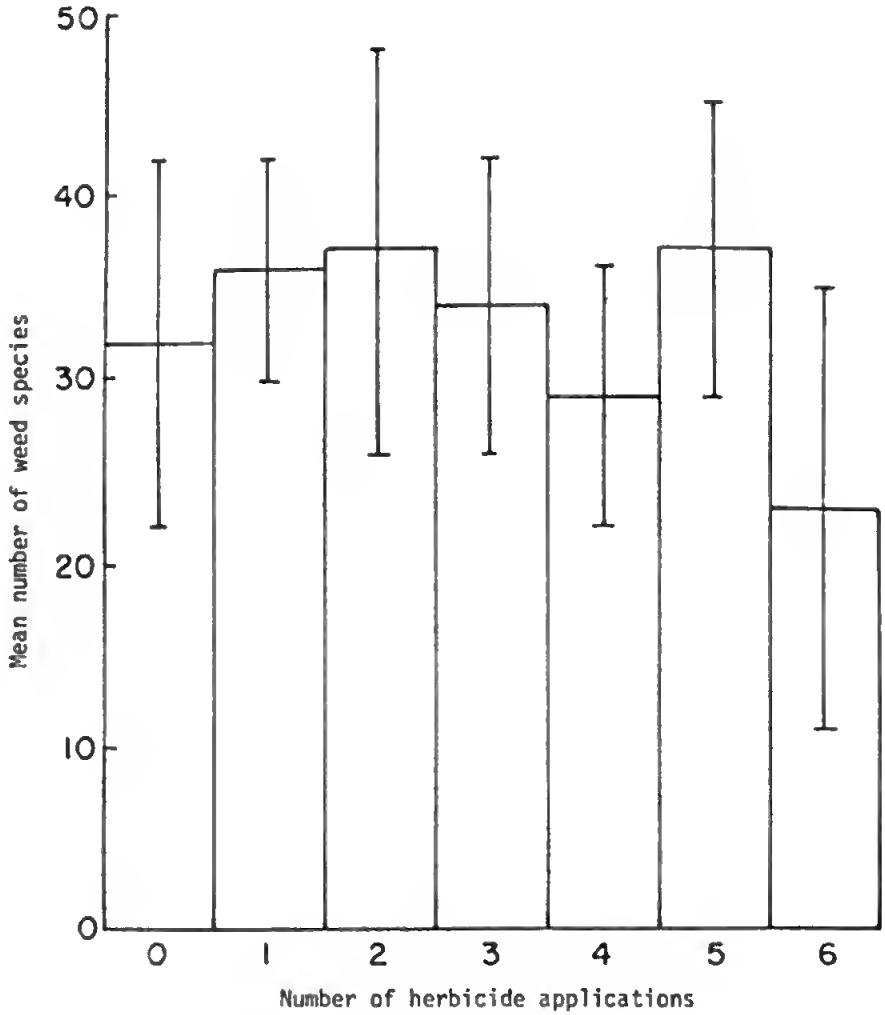

Fig.2. Mean number of weed epeciee in wheat in relation to the number of herbicide applications. Bars repreeent the etandard deviation.

The number of epeciee, as well as their density, did not show a clear trend as a result of an increasing number of herbicide applications (Figs.2 and 3). The standard deviations indicated a high variation within the data both for the number of weed species and the density of grase weed, in epite of the exclueive uee of phenoxy herbicides (Fig.3).

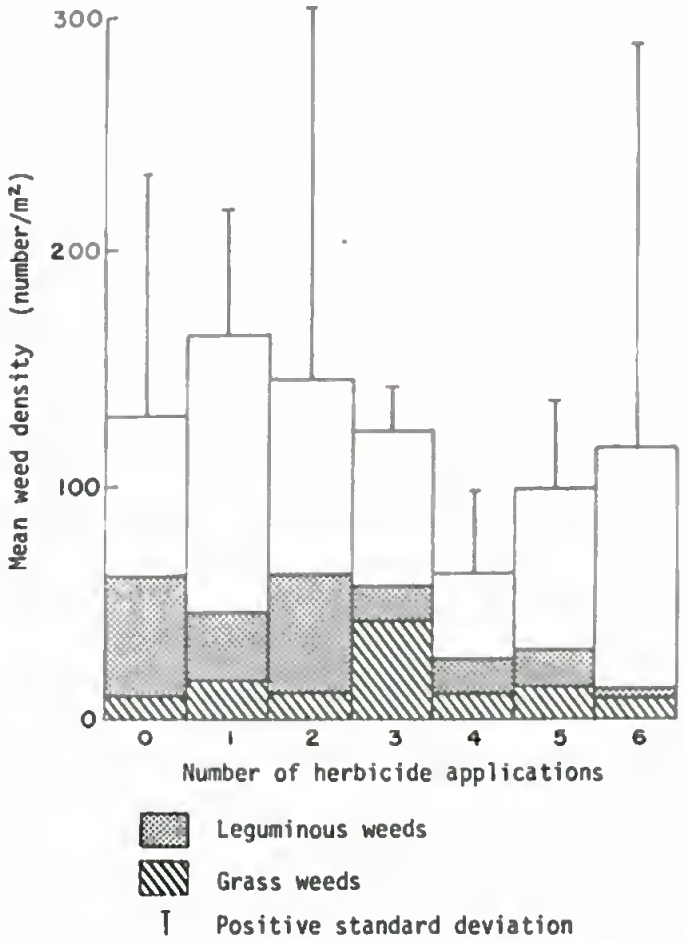

Fig.3. Weed density in relation to the number of herbicide applications.

On the other hand, the number of individuals of leguminous weed species, mostly Lathyrus inconspicuus in this case, diminished with an increase in the number of herbicide applications (Fig.3). The density of other species, such as Galium tricornutum and Malcolmia crenulata, also decreased, whilst the mean number of plants of the Ranunculus arvensis increased. This species was very common in fields that received five or six herbicide applications.

Table 3. Results of 2,4-D treatment on yield, wheat and weed densities

	Fields											
	1	2	3	4	5	6	7	8	9	10	11	12
	Yield (dt/ha)											
Herbicide treated	30.8*	24.6*	23.3*	25.0*	19.6	17.8	22.0	10.4	32.0	20.2	16.4	25.1*
Untreated control	16.6	17.8	19.8	21.3	18.8	16.3	22.4	11.9	34.0	22.2	17.5	28.8

*significant difference (p= 0.05)

Economic aspects of chemical weed control

Of the 12 fields included in this study, only four showed significant increases in wheat yield (between 17 and 18 percent) as a aerial application of 2,4-D. In seven fields no differences in yield were detectable, whilst in one case a significant decrease was observed to occur (Table 3).

Yields of untreated wheat differed greatly (from 11.9 dt/ha up to 34 dt/ha), although the seed-rate was 125 kg/ha in all fields. Differences might have been due to fertilizers, diseases or time of sowing.

Neither the density of wheat nor the density of weeds showed any clear relation to yields. Grass weeds were only of minor importance in all fields. In three fields (nos. 8, 9 and 11), the density of weeds was close to the economic threshold level and led to the decision to spray with herbicide. The yield, however, did not increase in all these cases. Weed control in general was around 80 percent effective. In two cases it was much less but, as a whole, no relation to yield could be found.

The herbicide used in the trials had to be applied between the wheat growth stages 15 and 30 (Zadoks et al., 1974) in order to avoid any crop damage. At these stages many of the weeds were already in the flowering stage.

DISCUSSION AND CONCLUSIONS

Many different factors are responsible for yield losses in crop production. Among these, there is little doubt that weeds are factors of major significance. The nature of the ecological challenge that weeds encounter and the evolutionary responses that evolve are complex and difficult to analyse. However, better information on changes in weed populations, as the result of changes in cropping systems, must be obtained. Without this and predictions of such changes, weeds will continue to remain one of the major limiting factors to increased yields (Moody, 1983b).

Weed communities in the Hasakeh Province represent the result of long-term influences by the wheat-fallow rotation. The local weed flora is very rich in species with more than 240 recorded. Also, the large extension of the wheat production area with its climatic gradients might influence weed composition and densities. As seen, Avena spp. are the species with the widest distribution but other grasses are common too. However, as far as competition with wheat is concerned, broadleaved weeds are more important.

Traditionally, seed bed preparation is the primary weed control

method in wheat. Fallow also plays an important role in weed control, although its function consists primarily of securing better water storage (e.g. Fenster and Peterson, 1979) and accumulation of nutrients (e.g. French, 1978). Two to three operations with a one-way disc in fallow were considered necessary for effective weed control in a spring wheat/summer fallow rotation in Canada (Lindwall and Anderson, 1981). Fallow is cultivated in the Hasakeh area up to four times. In this way, it is possible to keep the infestation of weeds in the crop more or less at the same level, as observed in this study.

Reduction of high weed densities can seldom be obtained with fallow cultivation alone. However, grass weeds can be maintained to a minimum through fallow. For example, the lifespan of Avena spp. seeds is relatively short and a large number of seeds already germinate in the first year. Fallow cultivation will eradicate them and reduce the seed reservoir. Moreover, grasses are the favourite feed of sheep and are grazed selectively (Koeder et al. 1982).

The farmer's level of weed control is often appropriate for the farming system that he practices. He would only respond to increased weed control measures if they were an integral part of a more remunerative farming system (Moody, 1983a).

In this respect, the weed control techniques applied in north-east Syria appear economically sound since the application of herbicides, in the majority of cases studied, did not increase wheat yields. This situation is not atypical. In fact, also in winter wheat production under much more intensive conditions in West Germany, where herbicides are used in nearly 100 percent of the area, it was recently proved that in 30 percent of cases weed control was uneconomical (Gerowitt et al. 1984). As for effects on wheat yields, results in the present study point to multi-factorial effects rather than to the effect of any single factor. This confirms that weed control should be considered as only one among several other factors affecting yield potential of a crop in a particular cropping system.

The potential increase in yield in the Hasakeh area, when herbicides were applied (and weeds were the limiting factor), can reach up to 87 percent. Even with a smaller yield increase (up by 20 percent corresponding to 3-6 dt/ha of wheat), the costs of herbicide application would be justified (Koeder et al. 1982).

Shifts of species in weed communities subjected to long-term herbicide application are frequently reported in literature. Within this study, no effects could be detected on the number of weed species or on the density of weeds. The highest number of six herbicide applications over the period of 12 years, including six

years of fallow, was probably too short to induce such changes. Shifts of dominance of a number of species could be detected by Koeder et al., (1982) after initial studies in the Hasakeh area. However, it is questionable whether the application of herbicides alone caused an increase or decrease in the number of certain weed species. In fact, farmers who apply herbicides over a long period of time are also introducing other changes such as new crop varieties, fertilizers, etc. Ths intensification of different cropping factors and their inter-play were found to be responsible for a change in a weed community in south-west Germany during the last 35 years (Mittnacht et al., 1979).

If the application of herbicides to control weeds should develop, the question arises as to whether fallow will continue to be necessary as a means of weed control. This is primarily a question of economics. However, the availability of herbicides at the proper time when they are actually needed is also to be seriously considered.

Until now in the wheat producing area of north-east Syria, broadleaved, annual winter weeds, which germinate more or less together with wheat, are the most important species. In lentil, they are much less common. Therefore, hardly any increass in their seed potential is to be expected by raising this crop. Lentils are sown later than wheat and their seed bed preparation at the end of autumn also controls weeds that have already germinated. A dense crop of lentil can probably compete successfully with weeds germinating later. Perennial weeds seem to find better conditions in lentil fields. One reason might be the reduced soil cultivation as compared to fallow, which, in general, favours perennial species. Chickpeas, on the other hand, compete much less well with weeds because they do not grow as high and their canopy density is less. All this leads to an increase in weed density following wheat crop, as observed in this study.

Increased cropping frequency with cereals (barley and wheat) can encourage well adapted weed populations whilst losing the regulating effect of fallow. In this case, direct weed control measures in the crop become increasingly more important, especially the application of herbicides. This appears to be ths case in the wheat-barley and wheat-barley-whsat rotations.

The majority of the broadleaved weeds in the above area are sensitive to 2,4-D, the herbicide most frsquently used. But the occurrence of weeds not sensitive to 2,4-D or to other phenoxy-herbicidss, is expected to increase, should the almost exclusive use of such herbicides continue in the future. Mainly grasses, and primarily Avena spp., are already very common in the area and show no preference for any of the crops cultivated. These weeds have

already caused trouble in many of the cereal-producing areas in the Mediterranean and other parts of the world. In 1983, herbicides were applied (especially for grass weeds) in some of the Hasakeh area. As already indicated, fallow cultivation reduces or, at least, holds the grass population in check, and grass weeds have not hitherto been a real problem. The new rotations, however, do not have these effects. Moreover, they provide favourable conditions for seed production of Avena spp. and other grass weeds in wheat and lentil, especially if herbicides eliminate competition from broadleaved weeds.

Chemical control of grass weeds is possible, but very expensive. Because of the comparatively high threshold levels and the high cost of chemical control, grass weeds are best controlled by cultural methods. Schneider et al., (1984) also confirm this for the high-input crop production situation in south-western Germany. As for broadleaved weeds, their rather cheap chemical control offers hardly any scope to the use of cropping methods for control. How the introduction of leguminous crops into the rotation affects grass weed populations in the long run, needs further investigation. Growing fodder, such as vetch, can control Avena spp. fairly effectively. Projects are already testing the introduction of fodder growing in some cooperatives in the Hasakeh area. But the majority of farmers have no livestock and, without incentives to compensate for the costs of fodder cropping, they are not likely to change their production system.

Studies are required to establish whether the new rotations are effective alternatives to raise agriculture production. Not only aspects of weed management are to be considered but also the whole farming system. Socio-economic and ecological evaluation both need to be included.

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PARASITIC WEEDS AND THEIR CONTROL IN THE NEAR EAST

C. Parker and A.K. Wilson
Weed Research Division, Long Ashton Research Station,
Yarnton, Oxford OX5 1PF, United Kingdom

Summary. Three main groups of parasitic weed are considered in detail for their distribution and importance in the Near East region. These are the dodders (Cuscuta species) the broomrapes (Orobanche species) and the witchweeds (Striga species). Some consideration is given to the Viscaceae and Loranthaceae (mistletoes) and other groups which cause minor and more localised problems in this region. Control measures are described for each main group, including the potential for chemical and cultural control, biocontrol and the use of resistant varieties. Rarely are completely effective measures available, but the integration of two or more approaches, if effectively implemented, could greatly reduce the menace of these serious pests.

INTRODUCTION

In recent years, parasitic weeds have been the subject of several symposia (EWRC 1973; Musselman et al., 1979; Ramaiah and Rao, 1983; Ayensu et al., 1984; Parker et al., 1984) and of a number of major review papers (Kasasian 1971; Parker 1980; Pieterse, 1979; Musselman 1980; Pieterse and Pesch 1983; Puzzilli, 1983). This paper will not attempt any comprehensive review of the whole subject, but will instead provide short summaries of the biology and distribution of the major species and their main host crops together with the control measures available or under current development. Emphasis will be on the most recent literature and on results of the past three or four years. Three main sections deal with the Cuscuta spp., Orobanche spp. and Striga spp., with short sections to highlight the problems with Viscaceae and Loranthaceae (mistletoes) and other groups which are minor and more localised in the Near East.

A great many species of Cuscuta are recorded in the Near East and they cause problems in most countries of the region (Table 1).

CUSCUTA SPECIES (DODDERS)

Unlike the root parasites Orobanche and Striga, the stem-parasites belonging to Cuscuta have unspecialised seed biology and germinate spontaneously without the involvement of any host plant.

It may, however, be significant for their success that most species tend to have a proportion of hard-seeds which require scarification before they can germinate. This results in a very prolonged pattern of germination over a period of years after seed-shedding, greatly reducing the risk of too many seeds germinating in the absence of suitable host plants. Once germinated, it is apparent that the seedling is unusual in that the radicle is quite abnormal, short and swollen, growing only about 1 cm before withering within a few days from germination. In the meantime, the shoot grows out as a slender yellow stem which "circumnutates", swinging in a wide circle, until it strikes any object, around which it will immediately start twining. If it is a suitable host stem, haustoria will begin to develop within days on the inner face of the coil and penetrate the host vascular tissue. If no host is contacted the seedling will lose capacity to parasitise after about seven days (Sitken, 1976).

Once attached to its host the Cuscuta seedling grows very rapidly. The haustoria have been shown to be potent metabolic sinks exerting a powerful drain on the resources of the host plant, and often preventing the formation or filling of fruits and seeds (Wolswinkel, 1977). Severe infestations can cause total crop failure.

The main agriculturally important species with distinguishing features are:

C.monogyna Vahl. Stems robust, mainly on woody hosts. Flowers 3-4 mm in an elongated raceme, capsule conical. Single stigma. Seeds 3 mm.

C.reflexa Roxb. Stems robust, on woody hosts. Flowers 6-8 mm. Capsule conical 5-10 mm. Stigmas 2, tapering, forming V. Seeds 3 mm.

C.campestris Yuncker. Stems medium 1-2 mm, bright orange/yellow, on a wide range of herbaceous crops and weeds. Grows also on citrus. Flowers 2-3 mm, corolla lobes with incurved tips, in clusters. Styles 2, tipped with small but distinct spherical stigmas. Capsules spherical, not circumcissile (splitting round the 'equator'). Seeds 1-1.5 mm. This is the most widespread agricultural problem of all Cuscuta species. Originating from N.America; it is not always listed in local floras and is frequently mis-identified, most often as "C.chinensis".

C.chinensis Lamarck. Stems slender, on a range of herbaceous hosts. Flowers 2-3 mm, tips of corolla lobes flattened. Styles 2 as C.campestris. Capsule spherical, circumcissile. Seeds 1-1.5 mm. At least some reports of this species are more correctly attributed to C.campestris.

C.planiflora Ten. Stems slender to medium, orange/yellow, on a wide range of herbaceous crops and weeds and small shrubs. Flowers 1.5-3.5 mm in very dense, compact clusters 4-12 mm across. Styles/

stigmas 2, long, slender. Capsule spherical. Seeds less than 1 mm. Dawson (1984a) pointed out that this species differs from C.campestris in not producing tendrils. The main stems therefore twine round the host, whereas in C.campestris only tendrils do so. The larger forms of this species are often referred to as C.approximata Bab.

C.pedicellata Ledeb. Stems slender, on a wide range of herbaceous crops and weeds including some grass species. Flowers 2-3 mm, mostly with only 4 corolla lobes. Styles/stigmas forming slender V. Capsule spherical. Seeds 1-1.5 mm.

C.palaestina Boiss. Stems very slender, mostly on shrubs. Flowers 1.5-2 mm, usually with only 4 corolla lobes, in compact clusters 4-6 mm across. Styles/stigmas forming slender V. Capsule spherical. Seeds about 1 mm.

C.epithymum (L.) L. Stems slender, reddish on a wide range of herbaceous crops and weeds. Flowers 2.5-4 mm in dense clusters 5-10 mm across. Styles/stigmas long, slender. Capsule spherical. Seeds 1 mm.

C.epilinum Weike. Stems slender to medium, little branched, mainly on flax and linseed. Flowers 3-3.5 mm in compact clusters about 10 mm across. Styles/stigmas forming V. Capsule spherical. Seeds 1-2 mm.

C.pedicellata is not always readily distinguished from C.palaestina, nor C.planiflora from C.epithymum, and several other species are recorded occasionally as weeds. Identification of Cuscuta spp. is difficult and professional taxonomic help should be sought before naming species for scientific record or experimental purposes.

Host plants:

Cuscuta species show less host specificity than the root parasites described later. Grasses are rarely attacked but a very wide range of herbaceous plants can be parasitized by most species. The age of the host may sometimes be critical and older plants, such as those of tomato, may become resistant (Sitkin, 1976). Nagar & Sanwal (1984) report that the resistance of potato to C.reflexa is apparently due to greater concentrations of calcium in this species. Weeds are often as much attacked as crops, and Convolvulus arvensis L. is one of the most favoured hosts in the region. Among crops most frequently parasitised, alfalfa is perhaps the most widespread throughout the region due largely to the spread of seed with the crop. Most vegetable crops are susceptible and problems are locally acute in many countries. C.campestris has recently been reported as a problem on lentil in Syria (Bellar and Kebabeh, 1983). Citrus crops are also very susceptible to several species and there are reports of serious damage from Saudi Arabia and Pakistan.

Control

Prevention/avoidance. The use of clean seed is vital in areas where Cuscuta does not already occur and desirable even where it does, to prevent further spread. Seed of alfalfa can be cleaned by specialised machinery using either velvet rollers or a combination of iron filings and magnets, to separate the rougher seeds of the parasite.

Cultural. Crop rotation including resistant crops such as small grain cereals and grasses, will help to contain the problem, but due to Cuscuta's wide host range, it is important to control the weeds even in a resistant crop such as grass, to prevent carry-over of the problem to the following crop and a building up of the seed supply in the soil. Kasasian (1977) reported reduction of the problem of C.campestris on alfalfa in Saudi Arabia following the more efficient control of Convolvulus arvensis on which the parasite was thriving around field edges. Cuscuta needs light to develop normally, and a dense, well-grown crop of alfalfa can provide useful control in the later stages if other methods of control have been used earlier on. (Dawson, 1984b).

Physical methods. Hand pulling is all that most growers are able to use, but the problem is rarely resolved in this way, as any fragments of parasite stem left with haustoria attached to host tissue can readily regrow and re-establish the infestation. Tillage (e.g. spike harrowing) is recommended at early stages in alfalfa to prevent the initial establishment of Cuscuta seedlings. On certain crops, particularly alfalfa which can recover from drastic defoliation and damage to above ground tissue, fire may be used shortly after a cut to destroy haustoria on the shoot bases. Large flame-throwers are used in the United States, and smaller hand-held machines could be suitable for small-scale growers especially in oil-producing countries with low oil prices.

Resistant varieties. Although there have been reports of resistance to Cuscuta, especially in older crop plants, there are no well-known cases of selection or development of new crop varieties for their resistance to Cuscata.

Chemical. Chemical equivalents of the flame-gun may also be used in alfalfa in the form of spot-spraying with the herbicides diquat or paraquat which have a non-selective scorching action but from which alfalfa can recover, when treatment is applied within a few days after cutting. Dinoseb-acetate and diesel oil have also been used in the same way in Turkey (Kurcman & Tastan, 1980).

For prevention of Cuscuta establishment, certain residual herbicides have been used such as chlorpropham, propyzamide and chlorthal-dimethyl in chickpea (Graph et al., 1982), chlorthal-dimethyl in carrot (Shlevin & Golan, 1982, Bueret & Neury, 1979), propyzamide in niger seed (Guizotia abyssinica (L.f. Cass) (Misra et al., 1981) in onions (Foschi & Rapparini 1977) and in a range of

legume crops (Rao and Gupta, 1981), and sulfallate + pebulate in tomatoes (Hutchinson, 1977).

These treatments are rarely completely effective, owing to their limited residual life in the soil, especially under warm conditions, but Dawson (1984c) has shown how the persistence, and hence effectiveness, of chlorpropham can be improved by a mixture with p-chlorophenyl-N-methylcarbamate (which is not yet available commercially) or with the insecticide, carbaryl, which has similar chemistry and is available commercially and registered for use in alfalfa.

In sugar beet, propyzamide 1.5-2 kg/ha applied at the 4-6 leaf stage has been successful in USSR (Svetievski et al. 1975) and in Italy (Foschi & Rapparini 1977). Ethofumesate 1 kg/ha pre-emergence or 0.6 kg/ha early post-emergence was next best after propyzamide in Foschi & Rapparini's work and is also suggested by Stojanovic and Mijatovic (1973). Cycloate has been successfully used as a pre-emergence treatment in Yugoslavia (Stojanovic and Mijatovic 1973). Perhaps the most interesting work has been that with maleic hydrazide. Belyaeva et al. (1978) report highly successful results with 7 kg/ha plus wetter when sprayed on to well established C.campestris on sugar beet in July. This kills the vines and reduces viability of any seed already produced. The growth of the crop may be checked, but yields of sugar tend to be increased.

Where establishment of Cuscuta occurs in alfalfa, an alternative to the drastic spot-burning or spraying is now available in the use of low doses of glyphosate, pioneered in USA by Dawson and Saghir (1983), but also confirmed in France (Hacquet et al. 1983, Fer, 1983, 1984). Apparently, glyphosate is translocated to, and accumulated by, the physiologically active Cuscuta growing points. Unfortunately, haustoria embedded in host tissue are not all killed and recovery can occur. The technique may also be applicable to some other host crops, but there is little experience with it yet in the Near East.

An even newer chemical control method has been suggested by Nagar and Sanwal (1984). Based on the observation of high calcium levels in Cuscuta-resistant plants they first showed calcium to be inhibitory to enzymes involved in penetration of Cuscuta haustoria, and then demonstrated that repeated spraying of simple Ca salts could protect susceptible plants from attack. No corroboratory results are yet available, but the principle appears promising.

Reports in earlier reviews (e.g. Kasasian 1971) of the effectiveness of antibiotics and fungicides have not yet been confirmed or further studied in recent years but deserve more attention.

Biological control. There have been studies of natural insect enemies of Cuscuta spp. especially by the Commonwealth Institute of Biological Control (CIBC) in Pakistan (e.g. Khan & Zafar, 1981, Baloch & Ghani, 1980). Recent reports also include those by B.D. Agrawal (1984) on the damage to Cuscuta by Smicronyx noridus Reich, a gall forming weevil in India; by Horvath (1983) recording that the related S.jungermanniae Reich has been used successfully on C.campestris in Hungary and by Shinkarenko (1982) reporting successful use of S.tartaricus Faust against C.campestris in Kazakhistan. There is almost certainly potential for greater use of these insects in the Near East region. There has been a verbal report of the use of a mycoherbicide approach to the problem in China using a Colletotrichum sp. but no details of this work are yet available.

OROBANCHE SPECIES (BROOMRAPES)

It is probable that the genus Orobanche originated in the Near East and that all the most agriculturally important species occur in the region (Table 1).

Orobanche species are root parasites. The adult plant produces vast quantities of minute seeds (0.25 mm long). These germinate to produce a "procaulome" only a few mm long in response to stimulant substances exuded by the host root. Attachment to a host root must occur within a few days of germination. A haustorium is formed which penetrates to the vascular tissue and establishes connections with the host xylem. A mass of tissue, or "nodule" develops up to 1 cm in diameter before a shoot is differentiated. This shoot emerges rapidly and produces flowers within a few days of emergence. No chlorophyll is formed and the parasite is totally dependent on the host for its nutrition. Damage to the host is not always obvious, but there is apparent interference with the host's ability to take up water. Damage is particularly severe under drought stress conditions. A formula for estimating loss of yield of Vicia faba L. from infestation by O.crenata has recently been published by Mesa-Garcia and Garcia-Torres (1984). A single emerged parasite per V.faba plant will reduce yield by 8 percent. Four to five parasites per plant will reduce yield by 50 percent.

Distinguishing features of the most important species in the region

O.crenata Forskal (= O.speciosa D.C.) 50-100 cm high, unbranched, flowers large up to 2 cm across, white with purple markings. Flower subtended by one bract only, no bracteoles.

O.cernua Loefl. (= O.cumana Wallr.) 20-50 cm high, unbranched, flowers up to 1 cm across, mainly pale but with dark blue/purple corolla lobes; single bracts only, no bracteoles.

O.ramosa L. 10-30 cm high, usually branched, flowers pale to bright

blue, up to 2 cm long, 1 cm across. Anthers glabrous (occasionally flowers white, and stems yellowish instead of tinged with purple). Flowers subtended by a bract and two bracteoles.

O.aegyptiaca Pers. 15-40 cm high, as O.ramosa, but flowers over 2 cm long and up to 2 cm across and anthers hairy.

The last two species are closely related and there appears to be a continuum from the very small form of O.ramosa spp. nana (also known as O.nana Noe.) through to large forms of O.aegyptiaca and O.ramosa spp. mutelii (also known as O.mutelii Schultz.). Distinction between O.aegyptiaca and O.mutelii is based mainly on the hairiness of the anthers.

Host plants:

Orobanche species have somewhat more restricted host range than Cuscuta, but less specificity than Striga spp., O.crenata is the most important species around the Mediterranean and occurs throughout as a severe problem on V.faba beans, often causing complete crop failure in such countries as Morocco, Egypt, Turkey, Lebanon, Syria. Other crops seriously affected include lentil in Syria, potato in Jordan, peas, carrots and safflower in Egypt. The weed Ammi majus L. (Umbelliferae) is also attacked. Chickpea usually escapes by being planted late, but early plantings with varieties resistant to Aschochyta rabiei (Pass.) Labrousse in Syria can be severely affected (S.T. Kukula, pers comm.). There is no clear evidence that the forms of O.crenata attacking these different crops are host specific.

Orobanche cernua is most common on Solanaceae, and tomato, eggplant and tobacco are widely attacked in Algeria, Jordan, Iraq, Iran, Afghanistan, Pakistan, Saudi Arabia, etc. Sunflower are also attacked. There is evidence that forms attacking Solanaceae do not attack sunflower and vice versa (Kleifeld & Herzlinger, 1984).

Orobanche ramosa and O.aegyptiaca are also most commonly troublesome on Solanaceae, particularly on tomato in Lebanon, Iraq, Saudi Arabia, Jordan and Sudan. Crops and weeds in many other families can also be attacked, such as Leguminosae, including V.faba, lentil, chickpea, etc; Cruciferae - oilseed rape (Brassica oleracea L.), Compositae - Flaveria trinervia (Spreng) Mohr. and Chenopodiaceae - Chenopodium murale L.

Control

Prevention/avoidance. The minute seeds of Orobanche are not readily detected in, or separated from, crop seed. Thus introduction of new infestations in this way cannot be so readily prevented as in the case of Cuscuta species. The seeds can also be distributed locally via soil, water and wind, so it is important to

remove adult plants from the field before flowering and seed production occur.

To some extent the problem can be avoided by planting non-susceptible crops. However, the wide host range of most species seriously limits the choice of rotational crop and often means giving up those most profitable. The slightly greater specificity of O.cernua suggests that this may be more readily avoided by such a strategy where this species is a problem. Considerabls attention should be given to controlling all secondary hosts of Orobanche species to prevent proliferation and carryover of infestation.

Cultural. Rotation of crops can eventually provide control but many years may be required for eradication. "Trap crops", which stimulate Orobanche seed germination, may help to hasten the process. For O.ramosa, flax has been shown to be effsctive (Abu Irmaileh, 1984).

O.crenata has a more complex germination ecology than the other species and has a strict pattern of seasonal behaviour, germinating most abundantly around November or December depending on locality. This can be exploited to avoid the most serious infestations, as noted above in the case of chickpea, and also reported recently for V.faba in Spain (Mesa Garcia & Garcia-Torres, 1982) and in Egypt (Nassib et al., 1985). The lattsr estimated emsrgence of 18,000 O.crenata plants per ha in a crop planted October 15 but only 4,000/ha in a November 15 planting.

O.ramosa, O.aegyptiaca and O.cernua all cause problems under irrigated conditions and are not suppressed by wet conditions as are Striga spp. (see below). Prolonged flooding has, however, been shown to be successful as a control measure for O.cernua in tobacco in India, and for O.crenata in Egypt.

Thers is some svidence for suppression of Orobanche by high fertilization, especially with nitrogen. Abu-Irmaileh (1981) reports suppression of O.ramosa in tomato but rates of fertilizer were exceptionally high. The method does not appear to be generally reliable or economic.

Physical. Hand-pulling has been recommended as a means of controlling O.cernua in tobacco in India, control being more-or-less complete after 3 years (Krishnamurty & Rao 1976). However, it is difficult to persuade farmers to follow this control. In some crops pulling may seriously disturb the crop root systems, as noted for eggplant by Misra et al 1982. Destruction of shoots by some means to prevent seeding must be considered as an essential part of a long-term control system, but it is clearly not practical as the primary means of controlling a dense infestation.

Experiments in Egypt and Syria comparing zero tillage and normal cultivation suggest that reduced cultivation increases the attack by O.crenata on V.faba (Nassib et al., 1985, Kukula and Masri, 1984).

A promising technique developed in recent years is the use of solar heating or "solarisation". This involves covering moist soil, at the hottest time of the year, with clear polyethylene film for a period of several weeks. Jacobsohn et al., (1980) reported successful control of O.aegyptiaca in carrots after 5 weeks, and some preliminary studies in Sudan (Braun et al., 1984) show promise. Temperatures in the top soil reach at least 55°C and many organisms are killed other than Orobanche, including some other weed species. The technique is, however, expensive and only appropriate to high value crops.

Resistant varieties. Varietal resistance of sunflower to O.cernua was recognized over 50 years ago and resistant varieties have been the main defence against this parasite in USSR ever since. The first varieties to be introduced apparently retained their resistance for some 30 years before more virulent forms of the parasite began to multiply and overcome the resistance. Further cycles of selection and breeding have been largely successful in combating these more virulent forms and detailed studies have established that the resistance results from a lignification response in the stele of resistant roots. Genetic studies show that resistance is associated with single dominant genes (Vranceanu et al., 1981).

No other crop has been so successfully selected or bred for resistance, but there is much current work on 'resistant' selections of V.faba in Spain (e.g. Hernandez, et al., 1984) and in Egypt, particularly with Giza 402 (Nassib et al., 1982, 1985). Some early reports suggested this variety had a very high degree of resistance to O.crenata, but it now appears that this resistance is somewhat affected by climatic conditions and to fail particularly under drier soil conditions. Nonetheless it is an approach deserving further study. Resistance of vetch (V.sativa L.) to O.crenata has been successfully identified in Spain by Martin et al. (1982).

Earlier reports suggested useful variations in susceptibility among varieties of tomato, tobacco, oilseed rape, and mustard but there is little published evidence that these differences have been fully confirmed or exploited. Some work still continues in USSR on tobacco (Vinogrador et al. 1981). In the case of tomato, there is continuing study of the possibilities for integrating varietal resistance to O.aegyptiaca with resistance to glyphosate, (C.L. Foy, pers. comm.).

Chemical. Allyl alcohol sprayed at 0.1 percent concentration is a well established alternative to hand-pulling as a means of destroying emerged Orobanche shoots and preventing new seeding, but the

chemical is not widely available. Oils have also been used but there is difficulty in avoiding damage to host crops.

The best results in recent years for preventing development and emergence of the parasite have been obtained with glyphosate. Following Kasasian's 1973 report on the selectivity of glyphosate at about 0.2 kg ai/ha against O.crenata on V.faba, many field studies have been conducted with somewhat varying results but with conclusively successful outcome in several countries of the region. These include Morocco (Schmitt et al. 1979), Egypt (Abdalla et al. 1983), Syria (Kukula & Masri 1984) and Cyprus (Americanos 1983). There have also been detailed studies in Spain which emphasize that a dose of 60 g ai/ha is well tolerated but that 120 g ai/ha may not be, hence the need for repetition of lower doses in preference to the application of a single larger dose (Mesa-Garcia et al. 1984). Two applications may be enough in conjunction with later planting, but to protect earlier plantings, in which germination and development occur over a longer period, three applications may be needed, starting from the earliest "nodule" stage. Nassib et al. (1985) showed better control of O.crenata by three glyphosate sprays than by two sprays even on later planted beans. Considerable yield increases have now been reported from several countries from the use of glyphosate in beans. Nassib et al. (1985) estimate a benefit: cost ratio of 3:1.

Most other crops are appreciably more susceptible to glyphosate than is V.faba, but tobacco is being treated commercially in Greece (S. Collins, pers. comm.) and from low doses of glyphosate applied overall to peas and lentil (Kelili et al. 1983), and eggplants, carrot and celery (Jacobsohn & Kelman 1980).

Many other herbicides such as trifluralin, diphenamid etc. have been previously reported to provide partial control of Orobanche species in various host crops but there is no evidence of practical exploitation of these results.

New reports, yet to be corroborated by further work, include that of partial control of O.crenata in V.faba following treatment of the seed with a mixture of fluazifop-butyl in oil (Haustorium 1984) and of control of Orobanche in tobacco following pre-emergence application of fluazifop-butyl at 1 kg/ha: also selective control of O.crenata in V.faba by application of chlorsulfuron at 1-2 g ai/ha (H. Adam, pers comm.).

Fumigants have been successfully used to control Orobanche, especially methyl bromide for O.ramosa in California. Metham-sodium and ethylene dibromide are less expensive, less hazardous alternatives which have been reported to give good results experimentally. However, no information is available that they are used in practice.

An alternative chemical approach is the use of substances which will trigger "suicidal" germination in the absence of a host. It is now well known that synthetic analogues of the natural Striga-stimulating substance strigol, known as GR7, GR24, etc., will stimulate germination of Orobanche. Also, there have been some encouraging results with the small quantities of chemical that have been available (Saghir et al. 1983). Unfortunately, there is no immediate prospect of these compounds becoming commercially available. Instead, the alternative germination stimulant ethylene gas, being used successfully on Striga in USA, is not generally found to be effective on Orobanche.

Biological control. The agromyzid fly Phytomyza orobanchia Kalt. has been successfully exploited for control of Orobanche spp. in USSR and Eastern Europe. The fly is not being used in the "classical" sense of importation and release in areas where it did not previously occur, but in an "inundative" mode. Shoots of infested plants are collected at the end of the season, complete with pupae in the seed capsule and stems, stored under suitable conditions (6-8°C and 75-85% RH.) over winter and then hung in fields where Orobanche is emerging (Klyueva & Pamukchi 1982). The fly is known to occur over much of the Near East region, for example in Turkey (Giray & Namli 1983), but it is not clear whether it could be exploited in the warmer areae. There are no adequate studies to show that it is not feasible. Such studies would appear to be overdue in the light of the very considerable successes reported.

Old reports of Fusarium spp. being used to control O.aegyptiaca by inoculation of the planting holes of the host crops, tobacco and melon (reviewed by Kasasian 1971), do not appear to have been confirmed or extended. Again, more study is required.

STRIGA SPECIES (WITCHWEEDS)

Striga speoies, or "witchweeds", are much more tropical in their distribution than either Cuscuta or Orobanche. They are consequently less widespread in the Near East Region (Table 1.). However, in those countries where they do occur, especially in Sudan, they affect much greater areas and cause much greater losses than all other parastic weed groups together.

The biology of the root parasitic Striga spp. is very similar to that of Orobanche in that the smallness of their seeds makes them obligate parasites only able to develop fully after attachment to a suitable host root. They likewise germinate only in response to stimulating root exudates, within a few mm of a crop root. After attachment, they develop as total parasites below ground but on emergence into light, chlorophyll is formed and the plants can photosynthesise and are no longer totally parasitic - hence the term

"hemi-parasite". It has now been shown that the efficiency of photosynthesis is only about 20 percent of that of a normal plant (Shah et al. 1984). Not only does the parasite continue to draw heavily on the host photosynthates, but it also causes other serious changes in the host physiology (e.g. Drennan & El Hiweiris 1979, Parker 1984). This may result in stimulation of the root systems but serious reduction in shoot growth. Estimates of crop loss are very few and unreliable, largely due to the near impossibility of immediate direct control. However, crop losses of 25-50 percent can commonly occur, especially where conditions of low soil fertility and erratic rainfall favour the parasites' development (e.g. Bebawi and Farah 1981).

Main distinguishing features of the two most important species

S.hermonthica (Del.) Benth. 15-100 cm high, flowers pink. Calyx ribs 5.

S.asiatica (L.) Kuntze (= S.lutea Lour). 15-30 cm high, flowers mainly white (drying brown) when occurring as a problem in this region (e.g. in Pakistan, S.W. Arabia). Also scarlet or yellow. Calyx ribs 10.

Other less important species:

S.gesnerioides (Willd.) Vatke (= S.orobanchoides Benth) 10-20 cm high, leaves reduced to scales. Much branched from the base and somewhat fleshy in forms attacking cowpea. Other forms more slender, less branched. Flowers usually pale mauve, calyx ribs 5.

S.densiflora Benth. 15-30 cm high, flowers white (drying bluish). Calyx ribs 5.

S.angustifolia Saldanha (= S.euphrasioides Benth.) 15-40 cm high, flowers white. Calyx ribs 15.

S.latericea Vatke. 15-50 cm high, flowers brick-red. Leaves broader than in other species and slightly toothed. Calyx ribs 15.

Host plants:

Striga species have varying degrees of host specificity. S.hermonthica attacks most tropical cereal crops, especially sorghum in Mauritania, Sudan, S.W. Arabia and Pakistan; Pennisetum millet in Western Sudan and Mauritania, and upland rice, maize finger millet and sugarcane more locally. A number of wild grasses are also parasitised. S.asiatica attacks sorghum in S.W. Arabia and Pakistan. It occurs more widely in Sudan, but in physiological forms which do not apparently attack crops.

S.gesnerioides has a number of races with very strict host specificity. The only one to affect crops in this region attacks

cowpea (Vigna unguiculata (L.) Walp.) in West Africa and this may occur in Mauritania. Other forms attack a range of other hosts, particularly Convolvulaceae and Euphorbiaceae, in Arabia, Sudan, etc.

S.densiflora is locally important on cereal crops and sugarcane in Pakistan and Oman. Some wild grasses are also susceptible.

S.angustifolia is recorded from cereal crops and sugarcane in Pakistan.

S.latericea has a distribution restricted to Eastern Africa and has recently been reported as a problem on sugarcane in Somalia (P.J. Terry pers. comm.). It also affects this crop in Ethiopia.

Control

Prevention/avoidance. As with Orobanche spp., the introduction or spread of Striga is not so readily prevented as is that of Cuscuta. This is because the seeds are minute (0.25 mm long) and can readily adhere to crop seed and be blown or carried by water over long distances. The precaution should, therefore, be taken to obtain crop seed only from uninfested areas.

The other form of prevention, as for Orobanche, is to avoid growing susceptible crops. Unfortunately, the range of suitable crops is often very restricted in the drought-prone areas most affected. Where conditions and other needs do permit, any broad-leaved crop will be suitable on land affected by the cereal Striga species. Any crop other than cowpea will be suitable on S.gesnerioides - infested land. Even where a cereal is affected, it is possible that another cereal could be grown safely. There is evidence of strong specificity of some populations of S.hermonthica and S.asiatica to either sorghum or to millet. Hence in Eastern Sudan and Ethiopa, and in parts of Arabia, millet might usually be safely grown on land where sorghum is attacked. But in Western Sudan S.hermonthica can attack both crops.

Cultural. The rotation of land into non-susceptible crops can be regarded not only as an avoidance method, but also as a means of reducing the problem for susceptible crops in the longer term. Unfortunately, the longevity of seeds in the soil can be at least 5 to 10 years, and severely infested land may need to be rotated into non-susceptible crops for several years before the problem is effectively reduced. As for Orobanche, there is evidence for certain non-host crops acting as trap crops because they exude germination stimulant from their roots and cause "suicidal" germination. Even these crops, however, do not always appear particularly beneficial, and more needs to be understood about the germination biology of Striga species and the factors affecting germination in the field.

The preference of Striga for dry conditions is not fully understood, but it does mean that irrigation generally suppresses it. Likewiee, date of planting can be important, i.e. planting immediately before the main continuous rainy period is preferable to planting on early rains which are more likely to be followed by a dry spell.

The association of Striga with conditions of low soil fertility is also not fully understood. Nitrogen appears to be the nutrient of greatest significance. The use of relatively high nitrogen fertilization is generally beneficial in at least delaying Striga emergence and in obtaining stronger crop growth (Bebawi 1981). Nitrogen helps maintain a high shoot to root ratio in the host, which doee not favour the parasite. Nitrogen also results in greater shading of the soil which is known to reduce Striga perhaps by lowering soil temperatures and hence preventing germination of Striga techniques such as more resistant varieties, nitrogen, denser planting, etc. so that hand-pulling becomes feasible.

Resistant varieties. Striga-resistant varieties of sorghum have been known for decades and the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) has made progress in the past 10 years in selecting and developing improved varieties. For S.asiatica there are promising new lines SAR1 and SAR2 available in India (Rao, 1984), while for S.hermonthica, Framida (SRN 4841) has been well proven in several areas (Ramaiah, 1984). The latter has red grain, however, and is not suitable for general use. Another red-grained type (Bahry) has been found resistant in N. Yemen (Stewart & Harris, 1983). ICRISAT now has some white-grained derivatives from Framida (and other resistant sources) in advanced trials (Ramaiah 1984) and ICRISAT should be approached for selections of varieties suited to particular areas. It must, however, be said that resistance is not complete and other control measures, such as nitrogen use and hand-pulling or other seed-prevention technique must be used in any long-term control effort. Such an integrated approach may also be important in preventing the selection of more virulent races of Striga which might overcome the reeistance (cf. O.cenua in sunflower above).

In Pennisetum millet progress has been slower but ISRISAT is now working with eome promieing lines, some of them derived from semi-wild "shibra" material in West Africa, NCo 376 is reported resietant (Deuse & Bassereau, 1980).

There has been little work on rice (only upland crops are affected), but in maize there are promising lines under study by the International Institute for Tropical Agriculture (IITA) (V.Parkinson, pers. comm.).

In cowpea, two lines (Suvita-2 and 58-57) highly resistant to S.gesnerioides have been identified by IITA (Aggarwal et al. 1984).

These are now subject to further study in West Africa and in U.K. Their resistance is excellent in Burkina Faso, but fails in Niger and Nigeria owing to more virulent races of the parasite.

Mechanisms of resistance are not yet fully understood. In sorghum the most promising lines appear to owe their resistance to low exudation of germination stimulants from their roots. In the resistant cowpea lines this does not appear to be the explanation (Polniaszek and Parker, unpublished). It is not yet clear whether mechanical barriers or chemical factors are involved in failure of attachment and development.

Chemical. Emerged plants of Striga can be killed quite readily by a number of herbicides applied directly onto the shoots. 2,4-D and paraquat are used routinely in maize in USA (Eplee, 1984), while bromoxynil and ametryne are less damaging to legume crops and have been recommended by Ogborn (1972) for use in mixed cropping situations in Nigeria. These treatments can be valuable for preventing seed production and may also reduce crop damage to some extent. Much of the damage to the host, however, is done before the parasite has emerged and treatment of the soil to give earlier control would be preferable. 2,4-D can be effective in this way also, as shown many years ago in Sudan and more recently in India (Korwar & Friesen, 1984). Timing may be critical in relation to time of germination and attachment of the parasite, and rain is also needed to leach the herbicide into the soil. This inexpensive herbicide deserves wider testing where sensitive crops do not preclude its use. However, 2,4-D is not likely to provide complete control.

In USA, oxyfluorfen has been used to give more reliable prevention of Striga emergence (Eplee, 1984). There is some evidence that the shoot tips of the weed are only killed as they reach the herbicide layer at the soil surface, but that damaging effects of the weed are not fully prevented.

Most recently there has been encouraging evidence for selective control of S.hermonthica in sorghum by pre-emergence or early post-emergence applications of the potent sulphonyl urea herbicide chlorsulfuron at 1-4 g ai/ha (H. Adam pers. comm.). The margin of selectivity is narrow but further work is well justified.

The most certain means of chemical control of Striga (as of Orobanche) is the use of volatile fumigants, and methylbromide is used for localised control in USA. A less complete, but highly effective chemical method in USA, is the use of ethylene gas to stimulate "suicidal" germination. A dose of 1-2 kg ai/ha injected at 15-30 cm depth in lines 1 m apart can give 80-90% germination of seed in the soil. The treatment is now a routine in USA for the eradication of S.asiatica (Eplee 1984).

S.hermonthica is also known to be stimulated by ethylene and ethephon (Babiker & Hamdoun, 1983), but the few field results so far available suggest only partial success (K.V. Ramaiah, pers. comm.). More work is needed to determine optimum conditions for use on this species. Activity on S.gesnerioides is thought to be lower.

The synthetic strigol analogues (GR7 GR24, etc.) have shown high activity on S.hermonthica and S.asiatica in vitro but field results have been less successful than ethylene (Babiker & Hamdoun, 1982). There has so far been no commercial development of these compounds.

Biological control. Studies by CIBC have pointed to several possibilities for classical biological control of Striga species by insects, e.g. by introduction of the moth Eulocastra argentisparsa Hamps. from India to Africa and of the gall forming weevils Smicronyx spp. from Africa to India (Greathead, 1984). Attempts have been made to introduce E.argentisparsa to Ethiopia but with uncertain results. Further study of the Smicronyx complex in West Africa is warranted as it can cause up to 80% reduction in seed production. Even if of no value for biological control elsewhere, it provides an important natural control on Striga which could be adversely influenced by insecticide use. Similarly, the microlepidopteran Stenoptilodes taprobanes Felder deserves more study for its significance in Sudan (Bashir & Musselman 1984).

Increasing interest in the development and use of "mycoherbicides" (the inundation of fields with spore suspensions of indigenous fungi) has stimulated some preliminary studies of possibilities on S.hermonthica and S.gesnerioides, but without practical outcome so far.

VISCACEAE AND LORANTHACEAE (MISTLETOES)

Information on mistletoes in the region has not been systematically surveyed but it is apparent that many species from both families are responsible for minor, localised problems in ornamental and fruit trees. Growth of mistletoes eventually results in death of the affected branch beyond the point of attachment and may also make the tree more susceptible to drought stress. Infestations are spread by birds carrying seeds from tree to tree. Germination and establishment of seedlings is slow and populations may take some months to build up to a serious infestation.

Means of control are very few. Most commonly pruning is used to remove the parasite but complete removal means removing the host branch on which it is growing. If only the parasite is cut, there is likely to be regrowth from the haustorial base. Biological control agents have been suggested, but none have yet been fully exploited.

The only recent advance in control measures is a technique for prolonged injections of a dilute formulation of herbicide into the tree stem. Ghosh et al. (1984) report successful control of Dendrophthoe falcata (L.f) Ettings on teak (Tectona grandis L.) in India using metribuzin at 0.1%. The technique deserves wider trial with different herbicides on other tree hosts. It would seem well worth testing the effect of trunk injection of bromacil or terbacil into citrus.

OTHER GROUPS

Thesium humile Vahl., a root parasite in the family Santalaceae has been reported as a problem on cereals in Libya (Abou-Raya & El Sharkawy, 1979), Morocco (M. Mouch, pers. comm.) and on onion in Jordan (Abu-Irmaileh, 1980).

Melampyrum arvense L. a facultative hemi-parasite in the Scrophulariaceae occurs as a problem on cereals in Turkey. There are reports of its successful control by bromoxynil + MCPA (Cetinsoy, 1980).

Cistanche spp. (Orobanchaceae) are widespread in the region. They are handsome plants, yellow-flowered and growing 1 metre high, generally in desert areas, where they usually attack wild vegetation, especially perennial Chenopodiaceae. Many other hosts can be attacked (K.C. Agrawal, 1984) and there are reports of a problem on sugar beet in Saudi Arabia (Awad Fageer Farah, pers. comm.).

CONCLUSIONS

For Cuscuta species the most important form of control is in the use of clean seed. Where this is combined with spot weeding by hand, fire or herbicide, the problem should be contained. Larger scale use of herbicide may be required in alfalfa and sugar beet.

Orobanche species present more intractable problems. They require long-term adjustment of rotations in the most serious instances involving the solanaceous crops tomato, tobacco, etc. for which direct control measures are not generally available. Where crop value permits, the use of fumigants and/or solar sterilization may be economic. In the case of Vicia faba beans, and perhaps some other crops, glyphosate offers an effective and generally economic solution which could almost certainly be more widely exploited.

For Striga, there are theoretical possibilities of avoidance and control by adjustment of rotations. However, this approach will not be widely acceptable. Resistant crop varieties are therefore the

primary component of any control programme combined with agronomic practices designed to raise fertility (especially N), increase shade and prevent parasite seed production (by pulling and/or herbicide).

For all groups of parasites, longer-term control programmes need an integrated approach and could benefit from more attention to the potential for bio-control. This approach could be an ideal subject for regional collaboration.

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Table 1. Distribution and importance of parasitic weeds in the Near East Region

Country	Cuscuta campestris	C.chinensis	C.epilinum	C.epithymum	C.palaestina	C.pedicellata	C.planiflora	C.reflexa	C.monogyna
Afghanistan	o	x		o			x	o	x
Algeria							x		
Behrain	o								
Cyprus	x		x		x		x		x
Djibouti									
Egypt	o	o	o	x	x	o	o		o
Iran	o		x	o	x	x	o		x
Iraq	o	x			o	x	x		x
Jordan	o			o		o	o		o
Kuwait						x	x		
Lebanon					o	x	o		
Libya	x			x	x	x	x		
Mauritania									
Morocco	o		o	x			o		o
Oman	o								
Pakistan	o						o	o	o
Qatar	o				x				
Saudi Arabia	o	x				x	x		
Somalia									
Sudan	o	x				o	o		
Syria	x			x	x		o		x
Tunisia				x	x		x	?	
Turkey	x		x	o		x	o		o
United Arab Emirates	x								
Yemen, North	x				x		x		
Yemen, South									

Table 1. (cont.) Distribution and importance of parasitic weeds in the Near East Region

Country	Orobanche aegyptiaca	O.cernua	O.crenata	O.ramosa	Striga angustifolia	S.asiatica	S.densiflora	S.gesnerioides	S.hermonthica	S.latericea
Afghanistan	o	o		o						
Algeria		x	o							
Behrain	x									
Cyprus			o							
Djibouti										
Egypt	o	o	o	o		(x)			o	
Iran	o	o		o						
Iraq	o	o	o	o						
Jordan	o	o	o	o						
Kuwait	x									
Lebanon	o	o	o	o						
Libya			x							
Mauritania	x							x	o	
Morocco	x	x	o	x				(x)	x	
Oman				x	(x)		o			
Pakistan	o	o	x		x	o				
Qatar				x						
Saudi Arabia	o	o		o				(x)	o	
Somalia		x								o
Sudan		o		o		(x)		(x)	o	
Syria	x		o	x						
Tunisia			o							
Turkey	o	o	o	o						
United Arab Emirates	x									
Yemen, North		o		o		o		(x)	o	
Yemen, South		o				o			o	

o known agricultural problem
x occurs and may be occasional problem
(x) occurs but not a problem (specific to wild plants only)
? occurrence uncertain

STORAGE AND DISTRIBUTION OF WEED MANAGEMENT DATA

W. Koch
Universtat Hohenheim, Stuttgart, Federal Republic of Germany

THE PROBLEM

Agriculture and, together with it, weed control, has to be adapted continously to the changing and developing socio-economic systems which it is part of. In this respect, one of the determining factors is the rapidly increasing human population in most parts of the world. Along with this goes the urbanization. Food production has to be increased far beyond subsistence. This is only possible by introduction of scientific knowledge and appropriate modern technologies in a systems approach.

Urbanization, alphabetization, industrialization highly affect the labor force available for weed control, which often is one of the limiting factors in a crop production system. In shifting cultivation, reduction of the fallow periods may drastically increase weed problems, e.g. Striga in sorghum and millet production. The introduction of new appropriate weed control strategies is necessary. In order to achieve this, not only research is necessary but also the transformation and dissemination of research findings. At present, the latter is one of the greatest handicaps in adapting crop production systems to the requirements of modern societies. Often, knowledge and know-how are available somewhere but not where they are needed. This problem is not as serious in highly industrialized countries as it is in Third World countries. If we do not find a proper solution soon, the inadequate possibilities of transfer and dissemination of information from the scientific level through extension to the farmer may be the main obstacle in improving food production sufficiently in many Third World countries and we will never overcome the surplus production in developed (industrialized) cropping systems and insufficient production in traditional ones.

The publications cited in the following literature list (1-64) cannot be more than a source for further information. The author is willing to improve and update such a list of references if there is an interest. He therefore asks the readers to give suggestions and provide him with relevant information.

THE TARGET GROUPS

The farmer is the final and only target of our information transfer. All other steps are intermediate ones. We have to bear this in mind. When we consider separately the different steps of

information transfer and the respective techniques available. Intermediate target groups are scientists and technical extension staff.

It is beyond question that the information has to be adapted to the respective target group.

At the scientific level, it is important to guarantee a rapid exchange of information so that research programs can be planned according to the latest status of scientific knowledge and duplication of work can be avoided as much as possible. At the extension level, one should not be confronted too much with detailed research methods and very theoretical and specific research results but rather with reviews of relevant developments in the respective disciplines given by qualified scientists who know of the needs of extensionists and advisory staff. The information flow from the scientist to the advisory staff may be somewhat slower than at the research level. From those reviews concepts have to be developed which might need some on-farm experimentation or which can be recommended directly to the farmer. The development of concepts - of management strategies in the case of weeds - requires a thorough knowledge of the respective ecological and socio-economic situations. The transfer of new concepts to the farmer may be slow but must be convincing. Usually the farmer adopts new ideas quickly, sometimes too quickly, if one is able to convince him of the advantage of the new concept. Of all the information available at the scientific level, only very little needs to reach the farmer. Most of it has to be sorted out, re-arranged, condensed to concepts and made acceptable on its way from the scientist to the farmer and this is one of the most difficult parts of our task.

STORAGE, TRANSFER AND DISSEMINATION OF INFORMATION

Storage, documentation

There are basically 10 possibilities to store information each one having a different accessibility:

- Unpublished reports aiming to inform the institution for which the information has been gathered; no or very limited distribution; hardly accessible for interested "outsiders"; may contain valuable information; the results of many weed control experiments are stored this way only; documentation centres should try to get access to as much of this information as possible
- Annual reports of local research stations (e.g. Agricultural Research Division, Sudan; 40) with very limited distribution and accessibility only; if one knows of the existence of such reports, the information may be used; may contain valuable information; the results of many weed

control experiments are stored this way only; documentation centres have access to a limited number of such reports only.

- Annual reports of International Agricultural Research Centres (e.g. ICARDA in Aleppo, Syria, 43) with fairly good distribution and accessibility; contain very valuable information; the results of many experiments on weed problems are stored this way; documentation centres have access to such reports.
- Series issued by different institutions; they often contain reviews or extensive reports; e.g. Schriftenreiche GTZ (7, 8,9,56), PLITS (12,50,61,62).
- Proceedings of expert consultation workshops, symposia and conferences are an excellent source of information; they may be region and topic specific and their publication usually does not take too long; sometimes their accessibility is somewhat limited; of special interest to countries of the Near East are, in the field of weeds, Proc. of workshops/ symposia on Striga (16,18,29,31), Proc. of symposium on weed research in Sudan (24, 25), Proc. of EWRS symposia on Mediterranean weeds (27), Proc. of symposia on parasitic weeds (28), Proceedings workshop on aquatic weeds in the Gezira canals (30), and the working papers of the FAO Expert Consultation in Nicosia (26).
- Journals contain a lot of information; depending on the target groups, those journals may be of more scientific or of more technical content, more or less subject specific, and more or less region specific; publication of results often is somewhat slow; they serve as a basis for further reproduction to a large extent; they are accessible and documentation centres use them as a major source of their information; of special interest for the Near East in the field of weeds are: Arab Journal of Plant Protection (32), Bitki Koruma Kursusu (crop protection journal, Turkey; very few publications on weeds; 33), DIRASAT (a Research Journal, published by the University of Jordan; some publications on weeds; 34), FAO Plant Protection Bulletin (35), Tropical Pest Management (36), Weed Research (38), Weed Science (39).
- Weed Abstracts (37), containing abstracts of most of the publications on weed problems.
- Documentation centres, replacing abstracting journals slowly; highly efficient but not everywhere available so far.
- Individual documentation of relevant information; reprints, microfilms; using conventional methods such as cards and punch cards or modern ones such as personal computer for documentation.
- Books on weeds and their control with special emphasis on the problems of the Near East are hardly available (e.g. 6-12, 62), but there are quite a few which contain useful information relevant to the area under consideration (e.g. 1,2,3,4,

5).

Dissemination

There are many ways of bringing information to the respective target groups:

- (weed) societies
- training courses
- workshops, symposia, conferences
- field days, demonstration experiments
- personal contact, advice
- radio
- television
- pamphlets, newsletters
- journals, series, abstracts, annotated bibliographies, monographs, reviews
- brochures, books

Each one of those has advantages and disadvantages. Normally, a combination of different means is the best solution. It is important, however, to coordinate different approaches properly. (Weed) societies as well as national and international institutions have to play an important role in helping to provide the necessary tools and in coordinating the possible approaches.

Let me try to demonstrate such an approach for the Near East. The result of this effort will be very incomplete but it could be a start. Everybody who has a suggestion could contribute by writing to the author. So we could gradually improve our concept.

Training courses, workshops, symposia and conferences are offered in the area from time to time. This shall not be discussed in more details here. Many countries have good rural radio and tv programs. They could offer information on weed problems, but according to my knowledge they hardly do so up until now.

Pamphlets, brochures and books are available to a limited extent. It is often not known what is available and there are language problems in many cases.

FAO is stimulating and (co)organizing training courses, workshops, symposia and the publication of proceedings and other brochures and books on specific aspects of weeds and their control. Presently, a book on weeds of fruit trees and vineyards is being prepared for the West Mediterranean by Moreira on behalf of FAO. The German Agency for Technical Cooperation (GTZ) has some bilateral programs underway in this area. These activities which are conducted partly in cooperation with the University of Hohenheim, FR Germany, also include weeds to some extent. Much of this work is published. Most

of it is still available (7-9, 24,25,45, 48-54,61,63,64). As far as GTZ publications are concerned, they can be requested from this institution. The French weed group at Montpellier has extensive experience, especially in Northern and Western Africa, also the British (producing Weed Abstracts, Tropical Pest Management and having special experience in the field of parasitic weeds). The International Plant Protection Center (IPPC) at Oregon, USA, is offering very useful information (short courses, newsletters, brochures, books) on weeds and their control. Much of this information is relevant to the Mediterranean area, too. The European Weed Research Society is putting some emphasis on Mediterranean weed problems and has conducted 3 symposia on this subject so far. In Morocco, there is a Weed Science Society (Societe Nationale de Malherbologie). The Arab institution ACSAD at Damascus, Syria, has conducted several weed courses in the past. The Technical Centre for Agricultural and Rural Co-operation (P.O.B. 380, 6700 AJ Wageningen, The Netherlands) is also producing and providing relevant literature.

ACCESSIBILITY AND UTILIZATION OF STORED INFORMATION

A lot of data are stored but are often not available where needed. It is not only that the information needed is not available to individual persons or groups of persons but also that available information is difficult to handle. It is often quite time consuming to separate the data needed for a specific purpose from those not necessary. According to the amount and diversity of information (number of key words) which has to be available more or less quickly on request and according to the facilities, the documentation system has to be chosen basically from the following:

- books and journals
- abstract journals
- conventional card indexing
- punch card indexing
- personal computer
- centralized documentation systems
- providing information on written request and/or distributing abstracts periodically
- online search
- systems approach.

What will be said for indexing publications is of course valid for documentation of any other information such as the results of experiments.

1. Books and journals

Books and journals are still a primary source of information. Therefore, the publication of books and journals which meet the

(local) requirements is highly important. This can be in connection with meetings (proceedings) or not. FAO is giving the publication of appropriate information high priority. In the field of weed control, FAO is looking for the specific regions and topics with a lack of published information. The idscussions in connection with this paper could end up in recommendations for publications, workshops and symposia on weed problems in the area. Institutions interested in supporting such activities could select certain topics from those recommendations.

2. Conventional card indexing

The conventional card indexing system is highly useful in the case of a limited number of key words (Fig.1). It needs one card for each key word of a publication, either with complete bibliographic citation or with complete citation only once and just the number of the relevant publications on the cards with the key words. It is desirable but not necessary to have a brief abstract of each publication on the card with the bibliographic data. The advantage of this system is that the search for information is quick, easy and cheap. The disadvantage is that indexing is expensive in the case of high numbers of key words (Fig.1).

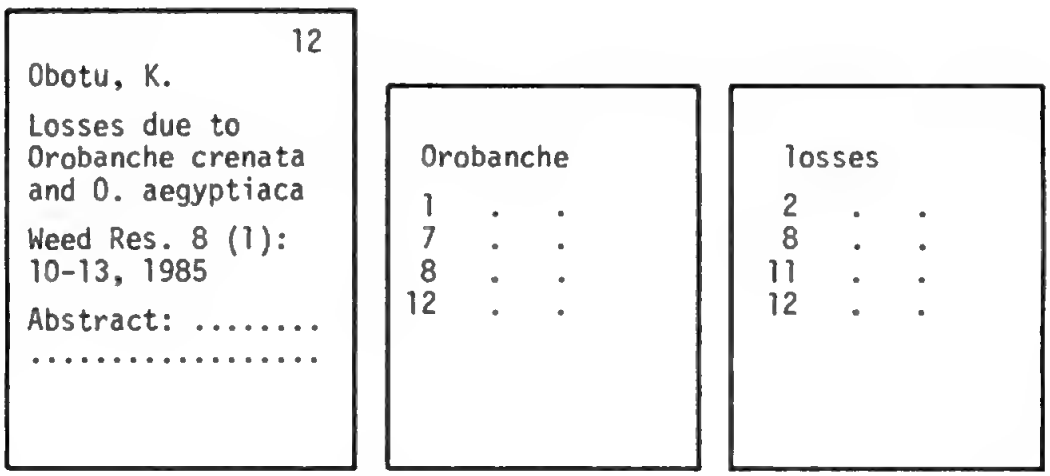

Fig.1. Conventional card indexing system (key words: Orobanche, losses, tomatoes, eggplants, Egypt)

3. Punch card indexing

Punch cards are especially useful in the case of a relatively high number of key words. Only one card contains all the information. All the keywords are on this card. The relevant key words are punched out (Fig.2).

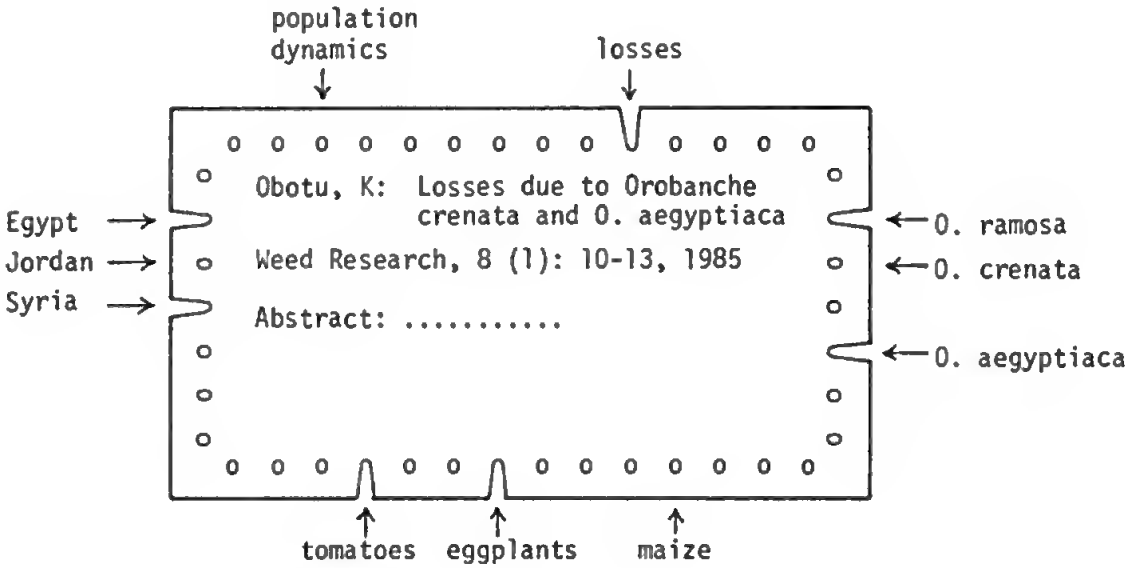

Fig.2. Punch card (key words: Orobanche ramosa, O.aegyptiaca, losses, tomatoes, eggplants, Egypt, Syria)

Searching for specific information, the cards with the respective key words punched out can be sorted out with a needle. This is still the most efficient indexing system for individuals or small groups. Often it supplements successfully the possibilities provided by documentation centres which in many cases are not detailed or specific enough for individual needs.

There are other systems similar to this one. What has been said about the punch card system refers basically also to the other similar ones.

4. Personal computer

If a personal computer is already available it may also be used for literature documentation. Normally, however, it is more useful for storing and processing experimental results. In any case, the use of a personal computer for documentation purposes must be planned and organized very carefully. There is a tremendous misuse at many places in this respect. Often data are being properly stored but hardly anybody is making use of them. In respect to documentation, the personal computer does not have an unquestionable advantage over more conventional documentation systems. This is different, where the processing of experimental results, office organization and documentation of literature as a whole are computer-based.

5. Centralized documentation systems

Centralized documentation systems are basically limited to "high input/high output" situations. Their operation requires capital, solid infrastructures, high numbers of users and science-based agricultural and industrial production systems. They are usually not sufficient as the only source of information but have to be supplemented by individually based information systems. In future we will depend more and more on such centralized systems. In the long run, they will replace at least in part scientific and to some extent also technical and extension journals. There is no need, however, to speed up this process too rapidly for it still has many weaknesses.

A cooperation between nations is necessary. International institutions could play a role in this process. To some extent, this takes place already when programs of scientific or technical cooperation are conducted between nations/institutions where such a service is available and those nations/institutions where it does not yet exist but where the information is needed. From this type of cooperation, all partners involved could benefit and the gradual introduction of the new system would be facilitated. Just an example from my own experience. We have joint research programs with Cukurova University at Adana, Turkey. The online search for relevant publications on weed problems is done through our university which is directly connected with such documentation centres. The specific literature for the Cukurova area is hardly available through the documentation centres but it is available locally and a research program can be based on a sound information background.

TYPE OF INFORMATION NEEDED

There is mainly a deficiency of information on local or regional

problems at all levels but especially at the farmer and advisory level. Often there exists relevant information somewhere else which could easily be adapted to local requirements. In order not to miss the target this has to be defined carefully; e.g.

- Increasing labour shortage requires the introduction of less time consuming technologies (e.g. herbicides); weed identification and the knowledge of the appropriate technologies become more important than before and the respective information has to be made available: e.g. on the weeds of the area, on relevant control measures, on site specific weed management strategies.
- Reduction of the fallow periods in sorghum shifting cultivation systems may lead to severe Striga problems; information on Striga and its control has to be made available for further site specific research and/or to extension-responsive farmers. The same is true for reduction of the number of fallow periods in wheat fallow cropping systems, where we might run into a wild oats problem.
- Introduction of new varieties or new crops may create new or enhance dramatically already existing weed problems, such as Orobanche with increasing vegetable production; information on the interrelationships between the respective production systems and their weeds as well as on possible strategies of control has to be made available for further site specific research and/or to extension-responsive farmers.
- Changes in the production systems due to the availability of new technologies, e.g. changes in type and intensity of soil cultivation, may be desirable. This may interfere severely with the weeds positively and negatively. On the other hand, new strategies of weed control will make a re-evalution of the importance of soil cultivation necessary. Site specific information on interrelationships between production systems and weeds has to be made available locally.

LITERATURE (selected, incomplete)

General, but with relevance to the area under consideration

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Weed identification

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SECTION D

COUNTRY STATUS PAPERS

WEED MANAGEMENT: COUNTRY STATUS PAPER - CYPRUS

P. G. Americanos
Agricultural Research Institute
Nicosia, Cyprus

G.P. Markoullis
Plant Protection Section
Department of Agriculture
Nicosia, Cyprus

BACKGROUND INFORMATION ON AGRICULTURE

Cyprus, with a total area of 9,251 km^2, has a typical Mediterranean climate with hot dry summers and temperate winters with variable rainfall which also varies with location. As an indication it can be said that the average rainfall is around 500 mm annually.

The major land use categories are shown in Table 1. The drastic reduction in the 1981 cultivated area compared to that of 1971 is due to the occupation of around 40% of the country's territory following the Turkish invasion of 1974.

Table 1. Major land use catergories

Land use categories	1960 Area	%	1971 Area	%	1981(a) Area	%
Agricultural land						
- cultivated	433	46.8	463	50.1	236	n.a.
- uncultivated	155	16.7	170	13.5	n.a.	n.a.
Forest	173	18.7	173	18.7	123	n.a.
Grazing land	86	9.3	96	10.4	n.a.	n.a.
Balance	79	8.5	68	7.3	n.a.	n.a.

(a) Data for 1981 refer to about 60% of the country being under Government control.

The main crops together with the area, production and value of each in 1982 are shown in Table 2.

Table 2. Area, production and value of main crops, 1982

Crop	Area (ha)	Production (tons)	Value Producer's price (£1000)
Cereals	51,540	90,240	8,957
Food legumes	1,928	4,040	1,246
Industrial crops	707	1,405	791
Fodder crops	23,153	n.a.	3,598
Potatoes	8,032	169,000	20,821
Other vegetables	4,628	95,790[a]	14,728
Table grapes	2,945	26,000	3,494
Wine grapes	30,522	172,000	11,971
Citrus	5,623	130,000	9,373
Fresh fruit	5,710	2,450	1,290
Olives	6,024	13,000	5,720
Carobs	8,032	12,000	1,038

[a]Green vegetables not included.

Of the above crops about 85% of potatoes is exported as is also 75% of citrus, 50% of vines and vine products, most of carobs and a large amount of vegetables.

The number of agricultural holdings was in 1977, nearly 44,000 with 282,000 plots covering a total area of just over 200,000 ha. The average holding size is 4.59 ha. Those engaged in agriculture number 44,800, representing 19.8% of the economically active population. The respective figure for 1960 when independence was gained was 40.3%.

THE WEED PROBLEM

Because of the favourable climate in Cyprus weeds are a very serious problem which is most acute in irrigated crops, especially vegetables. So much so that the availability or otherwise of a means of managing weeds is often the deciding factor on what to grow.

Fortunately our farmers take a very positive attitude to the weed problem and most of them incorporate a considered schedule of weed management in their cropping programme. In most cases this relies mainly on herbicides since labour is both scarce and expensive. Mechanical means are also widely used. The one negative

point in many farmer's attitude is that despite the importance they attach to a weed free crop they do not seem to realise that it is equally important to remove weeds as early as possible in order to avoid or minimise quantitative and qualitative losses.

Governments's attitude to the weed problem is also positive. It encouraged in 1953 the introduction of hormone weedkillers and actively contributed to their widespread use in cereals. More attention has been paid to the weed problem after independence in 1960. The Department of Agriculture was and still is, the main disseminator of information on weed management. With the foundation in 1962 of the Agricultural Research Institute the need for research in weed control was officially recognised. Some work was done in the period 1963-1968 and produced firm recommendations for herbicide use in carrots and for the control of wild oats in cereals. The appointment to the Institute in 1968 of a full time weed scientists heralded the era of systematic research on weed problems. The work since then has resulted in the formation of weed management programmes in twenty crops among which are all the major ones, while work in another four crops is approaching completion. Furthermore, the major weed species in the island have been identified as has also their resistance/susceptibility to a large number of herbicides.

The Department of Agriculture as the liaison between the A.R.I. and the farmers has made a very positive contribution in the battle against weeds.

ASSESSMENT OF CROP LOSSES DUE TO WEEDS

Trial work by the A.R.I. or the Dept. of Agriculture has produced the results summarised below:

Vegetable and field crops:

Broadbeans:	Losses due to the parasitic weed Orobanche			
	Light infestation	15 stems/m	20% loss)	irrigated
	Heavy infestation	50 stems/m	46% loss)	
	Light infestation	5 stems/m	79%	rainfed
Carrots:	Losses of up to 51% when weeds were removed by hand.			
Celery:	100% of seeded celery.			
Dwarf beans:	25% loss, weeds removed by hand.			
Lettuce:	Retardation of development of transplants and loss of quality.			
Onions:	45% loss when hand weeded.			
	100% loss when left unweeded.			
Peanuts:	10% loss when hand weeded			
	54% loss when left unweeded.			

Peas: Up to 72% loss when the crop was weeded at a late stage (crop ca. 40 cm high)

Peppers and Eggplants: no serious yield losses when handweeded but early yield was significantly reduced

Potatoes: Tuber yield losses ranged from 10% to 58% in unweeded plots, depending on the severity of weed infestation and the weed species present.

Rainfed cereals:

Losses due to wild oat:

a. light infestation 35 panicles/m^2 none
b. Moderate-heavy 120-300 panicles/m^2 46-58%

Losses due to mixed weed populations: up to 34%

Other:

Vines: 56% loss yield in unweeded plots.

CULTURAL PRACTICES USED BY SMALL SCALE FARMERS AND ON LARGE AND STATE RUN FARMS

Land preparation is almost entirely done by mechanical means. A variety of tools are employed, including ploughs, rotary tillers, harrows and disc harrows. These are attached to medium size-large tractors or, as in the hilly areas, to small hand operated tractors. On some very small or inaccessible plots animal-drawn implements are employed.

Water is a scarce commodity in Cyprus. The island has no lakes and no rivers with perennial flow. It's main source is the annual rainfall which is very variable, often with years of severe drought. To alleviate the problem the Government initiated, after independence in 1960, a big water development programme whose main objectives are to collect, store and properly use every available quantity of water. Within the framework of this project a large number of dams have been built while underground water has been exploited to advantage. The old and wasteful methods of irrigation by flooding or open furrow have been abandoned in favour of modern and more efficient methods which are being continuously introduced as soon as they are developed. It estimated that nowadays over 90% of the irrigated land is equipped with the latest irrigation systems which include:

a. Drip irrigation in vegetables, flowers, fruit trees, bananas and vines,
b. Mini-sprinklers (spitters) in fruit trees and bananas,
c. Low capacity sprinklers in potatoes, leafy and salad vegetables,
d. High capacity sprinklers in potatoes, forage crops, leafy and salad vegetables.

A large variety of fertilizer types are available and are being used (Table 3). Besides those types a variety of crystalline and other soluble fertilizers are being applied through irrigation systems.

Table 3. The quantity and value of fertilizer used in 1983.

Type of Fertilizer	No. of bags (50 kg)	Price/bag charged to farmers (£)	Total cost to farmers (£)
Sulphate of ammonia (21-0-0)	135,540	3.03	410,686
Urea (46-0-0)	76,160	5.93	451,628
Calcium Ammonium Nitrate (26-0-0)	124,560	4.22	525,643
Ammonium Nitrate (33/34-0-0)	34,260	5.06	173,355
Triple Superphosphate (0-42/48-0)	30,000	6.14	184,200
Potassium Sulphate (0-0-48/52)	10,040	7.41	74,396
Potassium Nitrate (13-0-46)	5,800	9.70	56,260
Mixed Fertilizers			
(20-20-0)	7,140	5.60	39,984
(16-8-8)	21,800	5.50	119,900
(12-20-7)	157,500	6.05	952,875
(16-20-0)	459,280	5.38	2,470,926
(15-15-7)	25,660	6.04	154,986
Other	-	-	332,000
TOTAL			5,946,839

Satisfactory mechanical methods of harvesting exist for a number of crops. Thus in cereals combine harvesters are exclusively used, while over 70% of peanuts are also mechanically harvested. In potatoes semi-mechanised methods of lifting are employed, although recently combine harvesters have been introduced.

In vegetables, fruit crops and vines hand picking is the common method of harvesting.

IMPORTANT WEEDS

A. Vegetables

I. Summer-autumn

Amaranthus spp.
Chenopodium spp.
Convolvulus arvensis
Cyperus rotundus
Digitaria sanguinalis
Erigeron annuus
Panicum colonum
Portulaca oleracea
Setaria verticillata
Solanum nigrum
Sorghum halepense

II. Winter-spring

Avena spp.
Beta vulgaris
Brassica kaber
Calendula persica
Fumaria spp.
Galium tricorne
Lolium rigidum
Malva sylvestris
Oxalis pes-caprae
Phalaris spp.
Sonchus oleraceous

Cuscuta sp
Orobanche spp.

B. Orchards

Amaranthus spp.
Chenopodium spp.
Convolvulus arvensis
Cynodon dactylon
Cyperus rotundus
Erigeron annuus
Helioscopium europaeum
Panicum colunum
Portulaca oleracea
Setaria verticillata
Solanum alatum
Sorghum halepense

Anagallis arvensis
Avena spp.
Brassica kaber
Calendula persica
Capsella bursa-pastoris
Lamium spp.
Lolium rigidum
Malva sylvestris
Oxalis pes-caprae
Phalaris spp.
Poa inferma
Scandix pecten-veneris
Sonchus oleraceous
Stellaria media
Urtica urens
Veronica spp.

C. Cereals

Anthesis coronaria
Avena spp.
Brassica kaber
Chrysanthemum coronarium + C.segetum
Fumaria spp.
Galium spp.
Gladiolus segetum
Lolium sp.
Matricaria chamomilla
Muscari spp.
Oxalis pes-caprae
Papaver rhoeas
Silene spp.

NEW WEED PROBLEMS

As far as we have been able to ascertain no new weed species have been lately introduced. However, minor species in certain crops have recently assumed major importance as a result of agronomic practices. The most important of such practices is the repeated use of the same class of herbicide. Outstanding examples are Torilis sp. in vineyards, which is resistant to simazine, the herbicide commonly used in that crop, and Galium sp. in potatoes. The repeated use of simazine in vineyards has also aggravated the problems of Cynodon dactylon, Melilotus sp., and Sorghum halepense.

Other examples of weeds with newly assumed importance are Oxalis pes-caprae in cereals and Convolvulus spp. in potatoes.

Axonopus sp. has recently established itself in many citrus orchards in the Nicosia and Famagusta districts. It is believed to be an introduced species, probably imported during the last decade in lawn seed mixtures.

LEGISLATION FOR WEED CONTROL

Cyprus has no legislation specifically concerned with weed control. However, the importation of several products is subject to conditions and restrictions aiming at preventing undesirable weed species from entering the country. Thus, lucerne must be substantially free from Cuscuta seeds, while the import of certain aquatic weeds which come exclusively from Singapore for use in aquariums, is restricted. Furthermore in the Importation of Produce (Control) Orders 1957-1974, regulating the imports of anything related to agriculture, there are restrictions, concerning the landing or importation of soil and gravel, leaf and garden mould, including soil adhering to or being present with imported plants, seeds or motor vehicles. The landing in Cyprus of fodder, hay and straw is only allowed under licence. Though this aims primarily at protecting our livestock industry from the Foot and Mouth disease, it also helps indirectly to prevent the introduction of undesirable seeds.

Living plants or parts thereof, rhizomes, seeds etc. are examined at the point of entry by authorised Agricultural Officers who allow or prohibit final clearance.

WEED MANAGEMENT

For the small scale farmer hand weeding has been the traditional and usually the only method of weed management. This rapidly changing mainly because of the availability of suitable herbicides for many crops, but also because of reluctance by the grower and members of his family to continue working unreasonably long hours. In some crops, e.g. vines where weed management was based on cultivations either by animal drawn implements or small hand cultivators there has been a rapid shift towards herbicides for both economic reasons and reasons of convenience, since herbicides can be easily applied using family labour and are largely independant of weather and soil conditions. In crops for which no suitable herbicide is available the cultivation is hired out to tractor owners. Sometimes, as in onions, broadbeans, cereals and some other crops the application of herbicides is handed over to contractors who often also provide the herbicide.

Large farms which have their own tractors and an array of tillage equipment, are slower in adopting chemical methods of weed management. The only exceptions concern potatoes and cereals, two crops in which herbicides are routinely used irrespective of the size of the holding. Large farms which are mainly cropping citrus and/or vines are now installing automatic irrigation equipment which hinders the passage of cultivation implements in all directions. This is forcing the managements gradually to reconsider their ideas on weed management. Already some are using herbicides along the tree rows where the pipes also run, and cultivate between the rows. Herbicides used are either pre-emergence supplemented by spot application of contact-translocated compounds against escaping weeds, or only post-emergence.

In state farms the situation is similar to that in large farms, although they are generally slower in incorporating herbicides in their weed management programmes.

Generally herbicides are making considerable headway because the scarcity and cost of labour almost prohibit hand weeding.

EXTENSION

The Agricultural Extension Service, which is a branch in the Department of Agriculture, is well organised with a network covering all the free territory. It is supported by specialist services at Headquarters in Nicosia and the District Agricultural Offices.

The Districts in the free area of the island are divided into 31 Agricultural Beats. For each Beat a qualified Agricultural Officer

is responsible, assisted by technicians and supported by specialists at District Headquarters. The average numbers of villages and farmers per Beat is 13 and 1500 respectively.

Methods used in extension include all the internationally accepted and proven ones which are listed below:

a. Personal contacts: it is considered the most important method and includes contacts at farmers' fields, in the Beat Officer's Headquarters, in Community Centres etc.

b. Field demonstrations: They are established by the Department every year and cover a wide range of topics both of local and national interest.

c. Field days: These are organized in rural areas or in Government Farms. During field days participating farmers are briefed on the latest developments on a specific topic.

d. Circular letters: sent to interested farmers and covering a wide range of topics.

e. Mass media: In a weekly television programme and in a twice weekly radio programme matters of current or special interest are presented to viewers/listeners. Both programmes are very popular with farmers.

Printed material in the form of bulletins and leaflets are prepared and distributed to farmers or other interested persons, free of charge.

f. Agricultural Exhibition: Held every two years, it affords a means of presenting to farmers and to the community at large recent developments in the agricultural and livestock sectors, as well as the activities of the various Departments of the Ministry of Agriculture and Natural Resources.

The efficiency of the extension methods is evaluated at quarterly district staff meetings in which specialists also participate.

TRAINING

Training courses which are quite frequent, and which are organised by the Dept. of Agriculture, often in co-operation with the Agricultural Research Institute, take several forms. The most important are the courses held in the two Farmers' Training Centres and which usually last 1-4 days, although longer courses are also held. Each course deals with a specific topic and the subject matter is presented by well qualified staff of the Ministry. Practical training often supplements the in-class training. In 1984, 59

such courses were held in the two Training Centres, and another six in Rural Centres.

Another form of training are talks, lectures and demonstrations by the Agricultural Beat Officers and specialist Extension Officers, presented at gatherings in the villages, usually at night. In 1984 211 demonstrations, 111 lectures and 74 talks were implemented, covering a wide range of topics.

Training of trainers also takes place regularly even though all Agricultural Beat Officers hold at least a B.Sc. degree and many of them also possess an M.Sc. in Rural Development. Training courses are held at the two Training Centres on specialised subjects. Specialists from headquarters of the Dept. of Agriculture and often from the A.R.I. who hold M.Sc. M.Phil. or Ph.D. degrees are in charge of the training. Furthermore, seminars are regularly organised for the professional and technical staff of the Dept. of Agriculture, in which special topics are presented and discussed in detail, and views and experiences are exchanged between specialists of the A.R.I. and the Dept of Agriculture, and Agricultural Beat Officers.

The efficiency of the training courses is hard to gauge but the fact that very often participating farmers return for training in other topics indicates that they were satisfied with the initial training.

ACCESS OF FARMERS TO WEED CONTROL PRODUCTS

Although the registration, import and distribution of herbicides are subject to approval by official bodies, a wide range of herbicides satisfying most needs are freely available. All major herbicide producers are represented in Cyprus, their local agents being actively engaged in promoting the use of herbicides, usually within the framework of the recommendations of the A.R.I. and the D.A. There has been a spectacular increase in the quantities of herbicides used in Cyprus over the past twenty years. In 1965 ca 10,000 kilos of a limited number (6-8) of herbicides were used while by 1983 the number of registered and approved herbicides had increased to over 50 and the quantity used exceeded 821,000 kilos.

All manner of application equipment, including sophisticated pieces such as the C.D.A., are available and are being used by our growers. The A.R.I. includes in its programme the testing of new application equipment.

The census of Agriculture of 1977 figured the number of hand-

operated sprayers to be 5,484, of mechanical sprayers 1,809 and of tractor mounted sprayers 1.146.

RESEARCH IN WEED CONTROL

Personnel involved in weed control is limited to one professional and one assistant on a full time basis. Two labourers are also used, part time.

Facilities available include a range of spraying equipment, vehicles, a laboratory and greenhouse space for bioassay tests. Requisites for field and laboratory work are freely available.

Perhaps the main problem is that most experiments have to be conducted in grower's fields because it is either impractical or impossible to lay down trials on land owned by Government. This, besides involving the risk of occasional interference by the grower, albeit unwillingly, also results in time being wasted in travelling to and from the experimental sites. Another problem is that the number of staff is inadequate to meet the pressing needs for research not only in weed control in various crops but also in several other aspects of weed management.

Despite the problems, weed control research in Cyprus can boast an impressive list of achievements. Thus, over the last 22 years as a result of research, weed control recommendations have been formulated for 21 crops, including all the major permanent agronomic and vegetable crops, and for one parasitic weed. Also a two-year country-wide survey of weeds in citrus orchards which resulted in the seasonal and quantitative determination of weed species in all localities has been carried out. Work in another four crops and on the control of resistant perennial grasses is in its final stages. The benefit to the economy, and to the farmers, from all this work is of the order of about C£5 million annually at constant prices at the time of completion of the relevant work. Further ongoing research concerns the study of the effect of herbicides on erosion, and bioassay tests to determine the residual effect of herbicides.

The Department of Agriculture through the Plant Protection Section carries out large scale trials to test the A.R.I.'s findings under grower's conditions. They also lay down demonstration trials for the benefit of the farmers.

LITERATURE ON WEED MANAGEMENT

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weeds. These are listed below in chronological order.

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Besides the above there is a number of articles in the popular magazine, "Countryman" published by the Ministry of Agriculture and Natural Resources.

The availability of references can be described as fairly satisfactory. The journal "Weed Science" is regularly received at the library of the A.R.I. as are also the "Weed Abstracts". Requests for reprints have so far always produced a favourable response. A number of volumes on weeds and weed control are also available at the library of the Dept. of Agriculture.

CONCLUSIONS AND SUGGESTIONS FOR IMPROVEMENT OF WEED MANAGEMENT

Although a lot has been done both in the research and in the extension field there is still much more to be done. The scarcity and high cost of labour make the use of herbicides imperative. But

the farmer must use the correct chemicals and rates for each crop. Practical information on this must originate from research. The ever increasing problem of resistant weeds must be tackled before it becomes a menace to our crops. The very serious aspect of residues should be studied so that information will be passed on to the farmer that will enable him to plan in safety his cropping sequence. The use of safeners must also be looked into and ways and means of more efficient and economic use of herbicides should receive proper attention. Possibilities for herbigation must also be investigated.

In the extension field every effort should be made to educate the farmers in the importance of the timely management of weeds, the proper use of herbicides and application equipment, the correct choice of follow-up crops, the recognition and early tackling of resistant species, the planned use of herbicides in perennial crops etc.

To achieve the above both the research and the extension weed management services will have to be strengthened. This is of special urgency in the extension field since the farmers are seeking, on an ever increasing scale, the guidance of extension personnel on matters relating to weed management.

On the regional level we feel that there is much scope for improvement on the present situation. In the first place meetings of this or a similar nature, in which there is a free exchange of ideas and experiences, will contribute much towards better understanding and solving common problems. Secondly, the setting up of a Regional Weed Management Centre, which will be directly linked with FAO HQs in Rome, will help to give an impetus to and will keep alive the interest in better weed management. The Centre can tackle such problems of common interest to all countries of the region as the testing of novel selective herbicides (e.g. graminicides) for the control of problem weeds (Cynodon, Sorghum, Convolvulus etc.) the testing of new application equipment with special emphasis on equipment suitable for use on small farms, the control of parasitic weeds, the herbicide/water relations, particularly in perennial crops, and others. The Centre can also provide services which on the national level may be difficult to make available e.g. bioassay studies. Finally, it can be the seat of a Regional Advisory Office and Training Centre for extension staff.

FURTHER INFORMATION AND COMMENTS

We warmly welcome the holding of the present consultation and we hope that it will be followed in due time by others. The region as a whole has a climate that encourages the rapid and abundant growth of weeds. It is also a region with limited water resources, therefore all losses to weeds should be minimised. We would like to think of this consultation as the beginning of an effort to initiate regional co-operation in the combat against weeds.

WEED MANAGEMENT: COUNTRY STATUS PAPER - EGYPT

T.S.I. Ibrahim
Weed Control Research Section
Sakha Experimental Station
Kafr El Sheikh, Egypt

Egyptian agriculture is one of the oldest in the world. It has been severely limited, however, to a narrow strip of land along the banks of the River Nile and to the fan-shaped Delta in Lower Egypt and covers only 2.8% of the total area of Egypt. With the severe shortage of farm land and the increasing population, the increase of crop yield per unit area through extensive research has become the only way to increase production and provide food security to the people.

Weed competition is one of the most important limiting factors responsible for low yields, and so weed control in field crops is an important practice for boosting crop yield. In egypt the increase in costs and crop production and the relative lack of human labor make it necessary to fit the use of herbicides into the production practices now in use in field crops. Hand weeding and hoeing have always been the common weed control practices, but since herbicides were introduced onto the State Farms and some farmers' fields in 1955 their use has expanded rapidly and at present about 50% of the cultivated area is treated with the recommended herbicides.

The latest recommendations for the use of herbicides in Egypt are summarised below:

HERBICIDE RECOMMENDATIONS

Winter crops		
Wheat and barley	-	'Brominal W' (bromoxynil octanoate)
Faba bean	-	'Igran' (terbutryne), 'Topogard' (terbutryne + terbuthylazine), glyphosate (for broomrape)
Onion (nursery)		'Tok' (nitrofen), 'Preforan' (fluorodifen), 'Eptam' (EPTC), 'Dacthal' (chlorthal-dimethyl)
Onion (transplants)		'Goal', 'Dacthal', 'Ronstar' (oxadiazon), 'Eptam', 'Stomp' (pendimethalin)
Sugarbeet		'Pyramen' (chloridazon), TCA, 'Pyramen + TCA', 'Pyradur'.
Summer crops		
Rice (nursery)		'Basagran' (bentazone), 'Stam F34' (propanil),

	'Ordram' (molinate), 'Ronstar' (oxadiazon), 'Saturn' (simetryne + thiobencarb)
Rice (direct seeded)	'Basagran', 'Stam F34', 'Saturn', 'Ronstar PL' (oxadiazon + propanil), 'Basagran PL2' (bentazone + propanil)
Rice (transplanted)	'Machete' (butachlor), 'Saturn', 'Ronstar', 'Stam F34', 'Machete' + 'Stam F34'
Maize	atrazine, 'Premextra', 'Bladex (cyanazine) + atrazine, 'Basagran'
Soyabean	'Basagran', 'Stomp', 'Blazer', 'Fusilad'
Sugar cane	'Gesapax combi' (ametryne + atrazine), 'Gramoxone' (paraquat).

In Egypt we have investigated an improved technique for easier application of chemical weed control material. The recommended rate of the soil active herbicide per feddan (1.03 acre) is mixed on the spot with fine earth or gypsum as a granular carrier (50 kg/ feddan) and broadcast on the soil surface or on the field water (rice). In this way there is no need for the tedious operation of spraying and there is no further need to import expensive granular formulations. (This method cannot work with contact herbicides).

MAJOR WEEDS IN FOOD CROPS IN EGYPT

Winter crops: - wheat, barley, faba bean, sugar beet, onion.
Ammi majus, *Beta vulgaris*, *Chicorium endivia*, *Medicago hispida*, *Melilotus indica*, *Rumex dentatus*, *Sinapis juncea*, *Sonchus oleraceus*

Summer crops: - rice.
Cyperus difformis, *Echinochloa crus-galli*, *E.colonum*, *Dinebra retroflexa*, *Eclipta alba*, *Juncus bufonius*, *Ammannia baccifera*.

- maize, soyabean, sugar cane.
Amaranthus paniculatus, *Corchorus olitorius*, *Dinebra retroflexa*, *Echinochloa colonum*, *Portulaca oleracea*, *Xanthium brasilicum*.

WEED MANAGEMENT IN DEVELOPED COUNTRIES IN THE NEAR EAST

Objectives

The principal objective of weed control programs in food crops is to reduce or eliminate yield losses caused by weed infestations and reduce labor costs and the need to hand-weed.

Specific objectives are:

1. To develop new technology and new chemical methods of weed control.

2. To improve the efficacy and safety of chemicals now in use.
3. To develop weed control practices that are effective for mechnical transplanting and direct seeding practices.
4. To improve existing weed control recommendations and put them into practice through the Extension Service.

These objectives aim to improve the incomes and economic welfare of small farmers. This goal can be reached through the following procedures:

a. Strengthening planning capabilities in weed science research and extension education
b. Devising more effective research and extension education administrative structures, policies and procedures.
c. Improving the facilities for weed control research and extension education.
d. Indicating programs aimed at motivating the adoption of production practices to increase yields, quality and net returns from crops.

The best approach for controlling weeds in food crops is to use an integrated system that combines preventative, cultural, mechanical, chemical and biological practices. Systems that omit any of these components are usually inadequate.

Cultural and mechanical practices are important components of weed control programs, but herbicides are essential for a control system to be effective.

A combination of herbicide treatments consisting of a tank mix or sequential application of a herbicide with pre-emergence activity and another with post-emergence activity controlled more weed species than single herbicide treatments, especially when cultural practices are mechanized.

For example rice production in Egypt provides an opportunity to reduce labor needs during peak labor requirement periods. The mechanical transplanting systems require younger seedlings (15-18 days after sowing) and shallower planting depth. Also there is considerable disturbance of the soil surface with the Japanese type of mechanical transplanter and the problem of variable numbers of seedlings per hill with the IRRI transplanter. Flooding and draining every two to three days is needed to ensure a high seedling survival rate.

Mechanical transplanters add to weed control difficulties. The smaller rice seedlings (than used in hand transplanting) are less competitive and the wider row spacing (30 cm) needed with the Japanese machine reduces the competition rice gives to weeds early

in the season. Our 1983-1985 results of herbicide trials with mechanically transplanted rice indicate that single herbicide treatments do not provide adequate weed control. However, several sequential treatments and/or mixtures of herbicides were effective. Butachlor, thiobencarb or oxadiazon applied either as a spray or granules four days after planting provided early control but an additional spray application of 'bentazon' + propanil was required for broad spectrum full season weed control. Other effective treatments were spray applications of thiobencarb + propanil, butachlor + propanil, Oxadiazon + propanil and 'Basagran' + propanil at the three leaf stage.

RECOMMENDATIONS

1. Special attention should be given to mechanized crop production to reduce labor costs and requirements for hand weeding.
2. The weed science specialist should increase the proportion of his activities conducted directly on farms by working cooperatively with extension workers. This has the advantage of answering the problems that exist under farm conditions.
3. The effect of water management on weed suppression and herbicide activity in rice is an important area of weed control research that could be strengthened.
4. Studies should be initiated in cooperation with plant pathologists to clarify and find answers to the observed problem of an increase in blast disease (neck infection in rice plants) severity in weed control plot areas.

WEED MANAGEMENT: COUNTRY STATUS PAPER - IRAN

S.H. Mirkamali
Weed Research Department
P.O. Box 1454, Tehran 19395, Iran

BACKGROUND INFORMATION ON AGRICULTURE

Iran is predominantly an agricultural country. Different geographical and climatic conditions make it favourable for the production of a diversity of tropical, subtropical and temperate crops.

The main field crops are: wheat 6 million ha (65% rainfed), barley 2 million ha (66% rainfed), rice 429 thousand/ha (paddy, mostly transplanted), cotton 183 thousand ha, and other crops including pulse legumes, industrial crops, forage crops and vegetables.

The main horticultural crops are: Citrus 115,000 ha, apple 134,000 ha, grape 203,000 ha, pistachio 121,000 ha, date palm 115,000 ha and several other horticultural crops.

THE WEED PROBLEM

Weeds, compared with diseases and pests, cause the greatest reduction in crop yields in Iran. There have been cases in which due to severe infestation of weeds, which have not been controlled efficiently, crop production has completely failed (potatoes, tomatoes, cucurbits, alfalfa, cereals and sugar beet). Weeds, in addition to crop losses, cause other direct and indirect problems in agriculture. Therefore, more attention has to be paid to their control.

ASSESSMENT OF CROP LOSSES DUE TO WEEDS

The average percentage of annual crop losses due to weeds is very difficult to estimate. It varies with crop, the year, the area and several other factors. What is certain is that the loss is very high.

We have crop losses between approximately 10% and complete failure in such crops as sugar beet, vegetables and wheat due to severe infestations of weeds.

Results of trials conducted by weed research staff of PPDRI give some idea of losses in certain crops (wheat, rice, potatoes and sugar beet) and are presented in Appendix I.

CULTURAL PRACTICES USED BY SMALL SCALE FARMERS AND LARGE STATE FARMS

In small scale farms mainly conventional cultural and mechanical practices of land preparation, seeding, irrigation and harvesting are used.

Large scale farmers usually apply modern machinery in all steps of crop production. They carry out rotational systems of cropping and apply suitable chemical fertilizers.

Important weeds

The most important weeds in selected crops in Iran are as follows:

Cereals, rainfed (Dry farming): Turgenia latifolia, Vaccaria pyramidata, Galium tricorne, etc.

Cereals, irrigated: Avena sterilis, Phalaris minor, Sinapis arvensis, Rapistrum rugosum, etc.

Rice: Echinochloa crus-galli, Cyperus difformis, Scirpus spp. and Alisma plantago-aquatica.

Sugar Beets: Amaranthus retroflexus, A.viridis, Chenopodium album, Malva nicaeensis (M.montanum), Echinochloa crus-galli, Avena sterilis and Phalaris minor.

Sugar Cane: Dichanthium annulatum and Imperata cylindrica, etc.

Vegetables: Amaranthus retroflexus, Chenopodium album, Solanum nigrum, Echinochloa crus-galli, Convolvulus arvensis, etc.

Parasitic weeds including Orobanche spp., and Cuscuta spp. are of high importance in these and several other crops.

Orchards: Cynodon dactylon, Paspalum disticum, Sorghum halepense, Phragmites australis, Imperata cylindrica, Cyperus rotundus, Convolvulus arvensis, Chenopodium album, Cuscuta mongyna and several other annual and perennial grasses and broad-leaved weeds.

NEW WEED PROBLEMS

At present we are faced with two relatively new and severe weed problems. The first is Phalaris minor in wheat, mostly in the north, and the second is Dicanthium annulatum in sugar cane in the south.

We have other recently imported weeds like Galinsoga parviflora in gardens which in some situations may become important. There will be also the risk of new weed problems through importing contaminated seeds of forage legumes and pasture plants.

LEGISLATION FOR WEED CONTROL

Herbicides are mostly imported or in some cases formulated in Iran under the direction of the Fertilizer and Pesticide Distribution Company (FPDC). They are distributed in the country and sold by government appointed private retailers at fixed prices. Herbicides are sold to the farmers under prescription from the expert personnel of the local agencies of the Plant Protection Organization (PPO) or the Plant Pests and Diseases Research Institute (PPDRI).

The farmers purchase and apply herbicides by themselves. In the case of severe and widespread infestations with weeds in certain crops like cereals, aircraft may be used to apply herbicides at relatively low cost.

We do not yet have well organized supervision of weed control.

WEED MANAGEMENT

The normal means of controlling weeds in Iran is hand hoeing which is carried out with several different types of hand tools. Small scale farmers, who comprise the majority of the farming population in Iran, usually only use hand hoeing to control weeds in their crops. In orchards ploughing and cutting by hand are normally practised. In spite of using large labour forces most of these types of fields and their edges are severely infested with weeds, especially at harvest time when it is of greater importance. The farmers do not understand or they are not able to apply the entire system necessary to control their weeds. In recent years some of the vegetable growers belonging to this sector of agriculture have become aware of herbicides and apply them with pleasure and satisfaction. Rice growers were familiarized with herbicides much earlier and apply them more extensively in transplanted rice fields and to some extent in the direct seeded fields as well.

Large scale and state farmers use different types of cultivation machinery and suitable herbicides and are less dependent on hand hoeing to control weeds. This sector of agriculture also finds it difficult to manage weeds, mainly due to the lack of experienced and trained personnel. In recent years we have seen severe weed problems growing in certain agricultural cooperatives in Moghan, Khuzestan and other provinces. Some action, however, is being taken to solve these problems.

EXTENSION

The field staff of the extension service, with the collaboration of the expert personnel of PPO and PPDRI, guide the farmers in the efficient use of herbicides. The establishment of demonstration fields to show the farmers modern weed control techniques is also carried out to some extent by this organization. These activities, however, are very limited and are not enough to overcome the severe need of the majority of the farmers to know more about the necessity and methods for improved weed management.

TRAINING

There are vocational high schools and 7 agricultural colleges in the country. In vocational high schools some practical knowledge of weeds and methods of their control is taught to the trainees. The graduates of these schools receive a diploma in agriculture and will have priority over graduates from other high schools when applying to enter agricultural colleges.

Agricultural colleges give three educational levels - BSc, MSc and PhD. In the BSc course a fundamental knowledge of the biology and control of weeds is taught. At present MSc and PhD courses are only set up for training in the fields of plant disease and pest control and not in weed management because of the lack of qualified professors in weed science.

At the moment the number of personnel engaged in weed management activities in the country have attained the following levels of education: PhD - 4; MSc - 16; BSc - 7. There are also a number of technicians of which one has finished vocational high school. In addition there are technicians who work as general assistants to the expert personnel on pests, diseases and weeds.

In-service training on weed control management is mostly given by the skilled staff of PPDRI to the junior staff of the institute before they go out to provinces. There are also short in-service training courses for the field staff of Agricultural Extension Service, P.P.O., teachers of Vocational high schools and of other organizations whose authorities feel the necessity of knowing more about weeds and weed control.

Training at the farmer level is not currently carried out. Providing different levels of training to weed specialized people is very important and is urgently needed to improve our present agricultural situation.

ACCESS OF FARMERS TO WEED CONTROL PRODUCTS

In the recent years herbicides, which are mainly imported as formulated products, have been distributed and sold directly by the government ifself or government appointed dealers at fixed prices all over the country.

Sprayers are also sold to approved qualified farmers by the above dealers at fixed prices.

Sometimes there may be short-comings in the distribution of herbicides and sprayers, but currently the government is actively thinking of ways to remove them.

RESEARCH IN WEED CONTROL

Research in weed control is mainly conducted by weed experts of PPDRI and its state laboratories, and to some extent by the Scientific and Industrial Research Organization (SIRO), the research division of the Tobacco Company and agricultural colleges. At the moment there are 26 weed experts and 2 technicians who are engaged in research in weed control. They are distributed as follows: 18 in PPDRI (6 in Tehran province and the remaining 12 personnel in 10 of the total 23 other states), 3 in agricultural colleges, 2 in SIRO and 1 in the tobacco company.

Irrespective of extra administrative regulations, there are difficulties in respect of the existing small number of weed expert personnel. Some of the personnel of the provinces who wish to receive MSc or PhD degrees have to leave their working place with the intention of receiving a higher educational level in a field of plant protection other than weed control because the latter is not yet established in any college in Iran. The other main problem is the unsuitable distribution of the personnel among the provinces.

Some of the current weed control research programmes in the country are as follows:

1. Chemical weed control in rice - transplanted and direct seeded;
2. Control of Phalaris spp. and Avena sterilis in rainfed wheat;
3. Chemical control of broadleaf weeds in dry farming wheat;
4. Chemical control of Glycyrrhiza glabra and Sophora alopecuroides (Goebelia alopecuroides) in dry farming wheat;
5. Chemical control of broadleaf weeds and grasses in sugar-beet;
6. Chemical control of annual weeds in potatoes;
7. Chemical control of annual and perennial grasses in alfalfa;

8. Chemical control of perennial grasses using glyphosate in mixtures with surfactants or ammonium suphate.

LITERATURE ON WEED MANAGEMENT

The national literature on weeds and weed control consists of 3 handbooks and a number of booklets in Persian and several articles, which have mostly been published in one of the journals of PPDRI (Plant Pests and Diseases or Plant Diseases), all having a summary in English. There are also technical articles relating to weed control published in journals of PPO, Ministry of Agriculture, etc.

We receive, however not completely, handbooks and journals on weeds and weed control from abroad. These publications could be found in the Libraries of PPDRI, Agricultural Colleges, Agricultural Research and Education Organisation and other governmental main libraries relating to agriculture and plant protection.

CONCLUSIONS AND SUGGESTIONS

Weeds cause severe crop losses and it is necessary to pay more attention to controlling them effectively.

Some suggestions for improvement in weed management are as follows:

1. Establishing and strengthening of training courses at different stages from farmers to technical personnel to acquaint them with the achievements of research and also to renew their knowledge in the field of weed control;
2. There should be certain arrangements to encourage the qualified weed experts to remain in the main agricultural crop production centres, which have much more severe problems in respect to weeds;
3. The agricultural extension service and the plant protection service should choose some of their qualified personnel and, after giving them suitable training, devote their time to weed management;
4. Agricultural colleges should be asked to rectify their shortage of trained professors in weed science and establish MSc and PhD courses in weed control. If there are no suitable candidates available in Iran consideration should be given to inviting university graduates from abroad;
5. Establishment and extension of intensive training centres with the necessary facilities for conducting courses in weed control is required.
6. Publication of booklets and posters at different levels for

the use of farmers and technical personnel is needed;

7. More efficient distribution of suitable herbicides and sprayers is very much needed;

8. The provision of more opportunities and facilities for the personnel engaged in weed control activities is suggested;

9. The administration should be more flexible and more efficient to ensure the best use of the available personnel;

10. The price of some products including wild oat herbicides are relatively high, even at governmental level, as compared with the crop price. Considerable discount in the prices of this type of herbicides to small scale farmers is suggested to encourage them to control weeds chemically.

11. As irrigation canals have a very important role in the distribution of weed seeds, I suggest that control of weeds in the canals be done with assistance of the government.

FURTHER INFORMATION AND COMMENTS

1. Setting up the current expert consultation on improved weed management for the Near East is gratefully appreciated. I suggest these efforts be continued in the future, possibly covering more countries of the region.

2. Establishment of weed experts societies in the countries of the region and making technical connections among them to solve the regional weed problems, with the assistance of FAO, is felt necessary.

Appendix I
Crop losses due to weeds in Iran

Wheat (Irrigated):

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Yield kg/ha Herb-treated	Hand-weeded	Check	Crop % Loss/ Herb.	% increase /check
72 (51)	Varamin	Avena sterilis	106 Panic		3998	-	3660	8.4	9.2
75 (54)	Khuzestan	"	11.52	BenzEthyl	4810	-	2470	48.6	94.7
75 (54)	"	"		"	4640	-	2440	47.4	90.1
77 (56)	"	"		"	4670	-	3818	18.2	22.3
80 (59)	Mazandaran	Phalaris sp. A.sterilis	12.37 33.1	Dicl-Methyl	6630	-	5456	17.7	21.2
82 (61)	Khuzestan	Phalaris + Avena	56.5 44.5	"	4481	-	4087	8.7	9.6
82 (61)	Mazandaran	A.sterilis	20.25	"	1284	-	695	45.8	84.7
83 (62)	Jiroft	Broadleaves grasses		Methab. thiazuron	4612	4853	4194	9.0	9.9
83 (62)	"	Broadleaves grasses		Methab. thiazuron	4612	5014	3938	14.6	17.1
83 (62)	"	Broadleaves grasses		Methab. thiazuron	4157	5177	3683	11.4	12.8

Appendix I (cont)
Crop losses due to weeds in Iran

Wheat (Irrigated)

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Yield kg/ha			Crop	
					Herb-treated	Hand-weeded	Check	% Loss /Herb.	% increase /check
83 (62)	Jiroft	Broadleaves Grasses		Methab. thiazuron	2600	-	1700	34.6	52.9
83 (62)	"	A.sterilis	210 Panic	Dicl-Methyl	4291	-	2516	41.3	66.5
83 (62)	"	Broadleaves		2,4-D	1700	-	1425	16.1	19.2
83 (62)	"	"		"	1975	-	1425	27.8	38.5
84 (63)	Mazandaran	Phalaris sp.			4939	-	3860	21.8	27.9
85 (64)	Fars	A.sterilis		Dicl-Methyl	5900	-	4180	29.1	41.1
85 (64)	Fars	"		Benz-Ethyl	4080	-	2730	33.0	49.4
85 (64)	Mazandaran	Phalaris brachystachys	20	Methab-thiazuron	4457	-	4083	8.3	9.1
85 (64)	"	Ph.minor	108 Spike	Dicl-Methyl				23.5	30.8

Appendix I (cont)
Crop losses due to weeds in Iran

Wheat (Dry Farming):

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Yield kg/ha Herb-treated	Hand-weeded	Check	Crop % Loss /Herb.	% Increase /check
83 (62)	Bakhtaran	Broadleaves		Methab thiazuron	1516	-	1383	8.7	9.6
83 (62)	Mogham	"	94	Mecoprop	2939	-	1781	39.4	65.0
84 (63)	"	"	259	Bromoxynil	881	901	578	34.3	52.4
85 (64)	Bakhtaran	Glycyrrhiza glabra	7.8	2,4-D	1636	-	1305	20.2	25.3
85 (64)	"	Goebelia alopecuroides	8.4	"	1513	-	1279	15.4	18.2
85 (64)	"	Broadleaves	228		2300	-	1940	15.6	18.5

Potatoes:

								% Loss /Herb.	% Increase /handweeded
82 (61)	Esfahan	Broadleaves	36.5	Metri-buzin	60500	55500	44500	8.2	9.0
82 (61)	"	"	63	Linuron	48570	43000	38120	11.4	12.9

Appendix I (cont)
Crop losses due to weeds in Iran

Potatoes:

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Yield kg/ha			Crop	
					Herb-treated	Hand-weeded	Check	% Loss /Herb.	% Increase /handweeded
82 (61)	Damavand	Amaranthus retroflexus Echinochloa crus-galli	373	Metrib+ Linuron	33200	25700	-	22.5	29.1
Sugar Beets:									
82 (61)	Fars	Broadleaves grasses	850	Chlorid.+ Triflural	39500	28000	4100	29.1	41.0
Rice (transplanted):									
66 (45)	Gilan	E.crus-galli Cyperus diformis	58	Propanil	3940	4919	4879	0	0
69 (48)	Mazandaran	E.crus-galli		Reyzel 2,4-D	1887	1820	1287	3.5	3.6
69 (48)	"	E.crus-galli		Reyzel	4525	4250	4150	6.0	6.4

Appendix I (cont)
Crop losses due to weeds in Iran

Rice (transplanted):

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Yield kg/ha			Crop	
					Herb-treated	Hand-weeded	Check	% Loss /Herb.	% Increase /handweeded
71 (50)	Gilan	E.crus-galli C.diformis	6	Molinate	1450	1750	1400	0	0
71 (50)	"	E.crus-galli C.diformis	163	Oxadiazon	4293	4029	2579	6.1	6.6
73 (52)	"				5975	4625	2700	22.5	29.1
73 (52)	"	E.crus-galli C.diformis	177	Benthiocarb	2945	2270	1518	22.9	25.0
73 (52)	"	E.crus-galli C.diformis	113		3775	3450	1347	8.6	9.4
73 (52)	"	E.crus-galli C.diformis	175	Benthiocarb	2942	2227	1518	24.3	32.1
75 (54)	"	E.crus-galli C.diformis	108	Benthiocarb	2985	2312	1350	22.5	29.1
76 (55)	Mazandaran	E.crus-galli C.diformis	96	Buthachlor	2312	1012	2769	56.2	128.4
77 (56)	"	E.crus-galli C.diformis	31	Oxadiazon	3775	3500	1347	7.2	7.8

Appendix I (cont)
Crop losses due to weeds in Iran

Rice (transplanted):

Year	Location	Weed species	Weed density (in sq m)	Herbicide	Herb-treated	Hand-weeded	Check	% Loss /Herb.	% Increase /handweeded
81 (60)	Esfahan	E.crus-galli Amania	367	Benthio-carb	4535	3850	2967	15.1	17.7
83 (62)	Gilan	E.crus-galli C.diformis Scirpus, Alisma		Benthio-carb	7470	-	4810		
83 (62)	Gilan	E.crus-galli C.diformis Scirpus	256	Oxadiazon	3735	-	2405		
84 (63)	Gilan	E.crus-galli C.diformis	153	Benthio-carb	1853	-	1970		

Reports from: Binesh, Faghih, Farahbakhsh, Fatemi, Rafii, Rahimi, Satei, Maddah, Mirkamali, Montazeri, Musavi.

WEED MANAGEMENT: COUNTRY STATUS PAPER - IRAQ

K.M. Al Kaisi
Weed Control Section, Plant Protection Research Center,
Abu Ghraib, Iraq

Crops.

The main field crops are: wheat, barley, rice, cotton, corn, tobacco;

vegetable crops: tomato, cucumber, eggplant, watermelon, onions, garlic and many others;

fruit trees: palms, oranges, grapes, etc.

Most of these crops are irrigated but about 70% of the wheat area and tobacco is rainfed.

The size of holding ranges from 30-500 donum (1 donum = ha) per person. About 50% of the population is engaged in agriculture.

Weeds.

The major weeds in Iraq are: Imperata cylindrica, Cynodon dactylon, Convolvulus arvensis, Avena fatua and many others.

All farmers wish to get rid of weeds but do little to control them.

The government is paying much attention to the weed problem through research and extension services and the free supply of herbicides and equipment.

Crop losses due to weeds

Crop losses due to weeds are valued at over 30 million Dinar a year. The losses per crop are estimated as:

Vegetables	30%	Wheat, rice barley	50%
Cotton	60%	Sugar beet	70%
Flax	70%	Corn	25%

Farming systems

In middle and southern parts of the country farms are irrigated either by flood systems or by water pumps; while in the northern parts most fields depend on rainfall.

Chemical fertilizers commonly used are urea and ammonium sulphate. Manures are used on vegetables and in orchards.

Field crops such as wheat and barley are harvested by combines and other crops usually by hand.

Weed problems and control

Weeds are introduced by irrigation water, wind, manure, contaminated seed and transplanted plants. There is no weed legislation yet in Iraq.

Cultivation is the main practice used for weed control by farmers and on state farms.

Herbicides are largely used in wheat, barley and rice while hand weeding is practised in the small vegetable fields and orchards.

The commonest herbicides in use at present are 2,4-D, propanil, trifluralin and benzoylprop-ethyl (Suffix). Large scale demonstration trials precede the release of new herbicides.

Training courses, including lectures and field practice, are arranged for farmers and government personnel. Herbicides and some equipment, especially those used in the main crops such as wheat and rice, are supplied free by government.

Research into weeds and their control started many years ago and big advances have been made in the last twenty years. Lack of staff is a problem. Several herbicides have been studied and recommendations made for their use. The growth habit and botanical description of common weeds in Iraq have been recorded.

Books have been published on weeds and weed control and in our library there are a number of international books on weeds. The exchange of information with neighbouring countries and internationally is, of course, of great importance for the improvement of weed management.

WEED MANAGEMENT: COUNTRY STATUS PAPER - JORDAN

B.E. Abu-Irmaileh
Faculty of Agriculture
University of Jordan
Amman, Jordan

BACKGROUND INFORMATION ON AGRICULTURE

The country is divided into two major geological parts (East and West banks) separated by a rift which cuts across the whole length of the country (named the Ghor) in which the Jordan River runs. The greater part of the land east of this Ghor depression is desert. The total area of the East bank is 9.3 million hectars of which only 8.6% receive more than 200 mm of rain annually. The total area under cultivation is not more than 500,000 hectars (Development Plan 1976-1980). Over 93% of the cultivated land is rainfed; the remaining 7% of the cultivated land is irrigated (Table 1).

Table 1. Land use on the East Bank of Jordan

Land use	Area (1000 ha)	%
Dry land (desert)	7500	81.0
Not suitable for cultivation	1190	12.9
Rainfed fiedl crops	490	5.3
Irrigated farm crops	40	0.4
Forest	40	0.4
Total	9360	100

Most parts of the cultivated land under rainfed conditions is characterized by traditional cultural practices which include improper land preparation, broadcasting of low yielding varieties, hand weeding, lack of fertilization and manual harvesting. Among the greatest handicaps for the Jordanian farmers is the lack of adequate rainfall, and poor distribution of precipitation. In addition, the small size of holdings hinders the rapid adoption of new techologies (Table 2)[2].

Table 2. Number and size of holdings

Number of holdings	Area	% of total
12347	Less than 1 ha	24.3
32244	Less than 5 ha	63.5
40878	Less than 10 ha	80.5
49716	Less than 50 ha	97.9

The total number of holdings amounts to 50791, and the total area is 400,000 ha. Most of it lies in the uplands. The area under cultivation is 58.7% of the total area of these holdings (Table 3)[2].

Table 3. Agricultural holdings land use in the East Bank excluding the Ghor

Land use	Area (1000 ha)	%
Unused	52	14.2
Fallow	80.9	22.2
Uncultivable	17.7	4.9
Cultivated	213.5	58.7

(2) Derived from the agriculture statistical yearbook and agricultural sample survey 1981. Dept. of Statistics-Jordan.

The cultivated area in the Ghor is mostly under irrigation which allows a better use of the land and better development of highly specialized large scale vegetable and fruit farming (Table 4).

Table 4. Land use in the Ghor 1981.
(Agriculture Statistics Yearbook 1981)

Land use	Area (1000 ha)	%
Unused	0.28	1
Uncultivated	0.6	2
Fallow	4.1	15
Cultivated	22.2	82

The cultivated area in the upland is mostly planted to field crops. And, the cultivated area in the Ghor is mostly planted to vegetables (Table 5)[2]

Table 5. Crop type distribution in the upland and the Ghor 1981.

Geographic area	Crop type	Area (1000 ha)	%
Uplands	Field crops	165	77.3
	Vegetables	15.8	7.4
	Fruit trees	32.7	15.3
	Total	213.5	100
Ghor	Field crops	3.6	18
	Vegetables	12.4	62
	Fruit trees	4.1	20
	Total	20.1	100

The instability of crop production especially in the rainfed areas forced an increased migration of labor force from agriculture to employment in the service sectors. Various reports indicate a decrease in the agriculture labor force. Steitieh et al (1978) reported that the agriculture labor force declined from 33% in 1961 to 17.6% in 1973. While, the percentage of the labor force increased in both construction and services.

Recently, Arabiat confirmed that the agricultural labor force is on the decline. It comprised 15% in 1979 and dropped to 10% in 1983. He believed that in the rainfed areas, farmers are reluctant to adopt new technology. However, investment in advanced agricultural practices had increased markedly in the irrigated areas.

Among the main crops grown on the East bank of Jordan, wheat stands as the principal cereal crop, followed by barley. Tomato is a major vegetable crop and olives is the main tree crop (Table 6).

Table 6. Five year averages of crop areas (1978 to 1982) grown on the East bank of Jordan.

Crop type	Crops	Area (1000 ha)	%
A. Field crops		184	100
	Wheat	114	62
	Barley	49	26.6
	Lentils	10	5.4
	Others (Vetches, Chickpeas....)	11	6
B. Vegetables		31.5	100
	Tomato	11	35
	Melons and watermelon	5	16
	Eggplants	3	9
	Squash	3	9
	Cucumber	2	7
	Others (Potato, Crucifers, Beans..)	6.6	21
C. Fruit trees		38.5	100
	Olives	30	78
	Grapes	3	8
	Citrus	3.8	10
	Banana	0.4	1
	Others (Stone fruits, Pome trees, Figs....)	1.5	3

Adoption of improved inputs varied among farmers in the rain-fed areas. El-Horani (1975) studied farmer responses to an improved package of technology for increasing wheat yield. He found that farmers are generally aware of the existence of the recent improved inputs and they anticipate yield increases from the adoption of such technologies. Still, their adoption rate for most parts is very low (Table 7).

Table 7. Adoption rate of improved inputs distributed by rainbelts

Improved inputs	Rain belt I (< 250 mm)	Rain belt II (250-300 mm)	Rain belt III (300-400 mm)	Rain belt IV (> 400 mm)
Proper tillage	0	0	0	0
Improved seeds	0	67%	75%	65%
Grain drills	0	0	4%	1.5%
Fertilizer	0	0	14%	11.5%
Chemical spraying	0	0	25%	17%
Clean summer fallow	0	0	5%	2.5%

The rationale behind the low adoption rate especially in the rainbelt I and II, is that the cost benefit ratio was not viewed as being high enough to encourage a positive adoption decision. An unusually dry season may be disastrous to wheat farmers who have gone into debt to apply expensive inputs. In addition to the high cost of inputs, the low price of wheat depresses profitability even in good rainly years. Furthermore, the lack of trained personnel, scarce availability of inputs at the proper time, limited research and extension are among the significant factors affecting the rate of adoption.

Wheat farmers, in most areas plow the field one time prior to seeding season, and only disc plow after seeding. The seed is normally broadcast by hand and covered by shallow tillage which results in irregular stands of wheat. The use of a grain drill is still in its initial stages. Fertilization of wheat is not common especially in areas receiving less than 400 mm of annual rainfall. Weed control is either performed by hand pulling or hand hoeing if any. However, chemical weed control is practiced in a significant part of the northern and middle parts of Jordan. Machinery and application is handled through cooperatives. The percentage of sprayed fields, however, does not exceed 2-5% of the total wheat area. Summer fallowing is traditionally carried out. Farmers leave the land idle without proper tillage or weed control during the fallow period.

This does not imply that improved inputs are not practised in the uplands. Statistical data (Arabiat, 1984) show that despite the real constraints to development, there is an increase in investments. The number of machines such as tractors increased from 2785 in 1970 to 4571 in 1980. Combine harvesters increased from 3 in 1970 to 20 in 1980.

In contrast to the rainfed areas, the irrigated sector has been witnessing significant development and the adoption of the most recent inputs, inspite of the high cost because the benefit is rewarding. Drip irrigation, culture under plastic houses or tunnels, plastic mulching, the use of soil fumigation, the shift from traditional to recent decision making in planting crop types, improved varieties, fertilizer application, grading, ... are expanding in the vegetable production areas in the Jordan Valley. A recent survey (personal communication) indicated that the number of plastic houses increased from 1783 in 1979 to 16640 in 1984. The area of each plastic house is 500 m^2, mostly planted to cucumber.

THE WEED PROBLEM

Farmers always combat weeds. A general practice for weed control in the rainfed areas is to plow the field after the first rain before sowing. This practice generally reduces the weed population. However, it brings about a delay in planting which sometimes extends for one month. Farmers are aware of the harmful effect of weeds on yield and quality, and on soil moisture depletion especially in dry land farming under conditions of limited rainfall. Farmers believe that heavy weed infestation reduces the yield by 33% (Arabiat et al. 1982). The results of weed losses experiments confirm the farmers belief, and show 30% yield loss due to weeds (Abu-Irmaileh, 1984). Yield losses vary with the intensity of weed infestation, and types of weeds.

Weed control in irrigated areas is more intensive than that in the rainfed areas. Farmers tend to hand hoe their fields 2 to 3 times per season, mainly to get rid of weeds. The new advancement in using black plastic mulch does not only control weeds, but increases the yield. Yield losses indicated a crop failure if weeds were not removed (Dweik and Abu-Irmaileh, 1984). However, if weeds were not removed 4,6 or 8 weeks after planting, yield reductions in eggplants were 14,14 and 39%, respectively: in pepper 5, 43 and 55% respectively; and in tomato 3, 11, 31, respectively.

The common weeds in the rainfed areas include[8]: Sinapis arvensis, S.alba, Convolvulus arvensis, C.betonicifolius, Vaccaria pyramidata, Silene conoidea, Asperula arvensis, Falcaria vulgaris, Galium tricornutum, Ridolfia segetum, Tetragonolobus palaestinus, Cephalaria syriaca, Hordeum spp., Phalaris purdoxa, P.canariensis, Avena sterilis.

The common weeds in vegetable crops grown in the Ghor include (Dweik, 1982): Sonchus oleraceus, Anthemis palaestina, Amaranthus retroflexus, A.gracilis, Chenopodium murale, Polygonum aviculare,

Sinapis arvensis, Portulaca oleracea, Lolium spp., Convolvulus arvensis, Malva nicaeensis, Phalaris brachystachys, Sisymbrium irio.

In addition to the previous list of weeds in vegetables, the following weeds are common in citrus orchards in the Ghor area (Abu-Irmaileh, 1982): Sorghum halepense, Cyperus rotundus, Cynodon dactylon, Prosopis fracta.

Parasitic weeds also threaten the culture of certain crops, Orobanche spp., specially O.ramosa forced the farmers to shift tobacco culture from infested fields to Orobanche free fields.

Early infestation of Orobanche ramosa or O.aegyptiaca can cause disastrous yield losses to tomato or eggplants (Abu-Irmaileh, 1985).

Other parasitic weeds that damage various vegetable crops include Cuscuta spp. However, the problem of Cuscuta has not been intensified yet. The major Cuscuta sp. in the Ghor area is Cuscuta campestris, and I believe it has escaped through the borders across the Jordan River.

Weed control research started in 1968 with an Oregon State University-AID sponsored project in wheat. This opened the horizon to chemical weed control in Jordan. However, due to limited trained personnel in weed control, research as well as extension is still limited in all major crops. Agri-chemical dealers also lack the trained personnel for disseminating herbicides. The amount of herbicide imported and registered through the Ministry of Agriuclture in 1980 did not exceed 2% of the total imported pesticides (Report of the Pesticides Committee, 1981, Ministry of Agriculture - in Arabic). Major herbicides used in Jordan are of the phenoxy type which are active only on broadleaf weeds. But, our surveys indicate that serious weed problems that cannot be controlled by this type of herbicide are spreading. Our studies (Abu-Irmaileh, 1985) indicate that even when broadleaf weeds are controlled by 2,4-D the wheat yield does not increase because of the build up of grasses in the sprayed plots which severely compete with the crop.

Extension in weed control is handled by the Ministry of Agriculture. Field demonstrations and field days are performed annually to show the efficiency of improved inputs in boosting yields in cereals. Farmers buy their seed through the Ministry. However, other agricultural sectors are not handled yet. Training courses are also handled through the Ministry projects in various areas of production, but weed control is one area that need more attention.

Cooperatives are efficient vehicles for disseminating new technologies. Machinery, application equipment and trained personnel for applying herbicides are not available to all farmers. Coopera-

tives help to solve such problems, but better care and handling is still required from the Ministry of Agriculture.

CONCLUSIONS

In conclusion, weeds pose serious problems to crops and hamper production. The farmers are aware of the harmful effects of weeds, but a lack of knowledge limits advancement in weed control technology. Most of the attention is being paid to cereals - especially wheat production - and other areas are not being equally treated. It is so important that well trained personnel should be available in the country in sifficient numbers to cover the major production areas of Jordan. The following are suggestions for improving the picture of weed control in Jordan.

- There should be about 10 trained weed control specialists distributed in the upland and Jordan valley (Ghor).
- There should be over 30 herbicide applying specialists that are licensed to apply herbicides.
- There should be a workshop in each major production area in Jordan (about 5) for maintaining and building up spraying equipment.
- There should be annual regional meetings to discuss weed control problems at specific times prior to planting crops, in order to set the specific needs for controlling weeds ahead of time.
- There should be at least one or two PhD weed control specialists in the Ministry of Agriculture to direct weed control in Jordan.
- The Government of Jordan should help and subsidise weed control equipment and materials to make sure that the farmers can afford the cost.
- Research on weed control for general and specific weeds should be intensified all over the cultivated areas.
- Cooperation with regional and international associations is imperative. Weed control conferences should be held in order to exchange and disseminate scientific information.
- The private sector should be obliged to participate effectively in weed control.
- Marketing is another important aspect that should not be neglected. Farmers should be able to market their produce with at least marginal profit.

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WEED MANAGEMENT: COUNTRY STATUS PAPER - LEBANON

Improved weed management in Lebanon

A.R. Saghir
Department of Weed Science
American University of Beirut
Beirut, Lebanon

INTRODUCTION

Lebanon has a total area of 10.45 million hectares with almost 1/3 of this area cultivated with permanent or temporary crops. About 25% of the arable land is irrigated, and the remainder is rainfed. The rain comes mainly during the fall and winter, between November and March, and the summer is usually dry. The mountains and coastal areas receive about 1000 mm of precipitation annually, whereas the Beka'a plain averages about 450 mm.

The major perennial crops in Lebanon include olives, grapes, apples, citrus, stone fruits and bananas; whereas the annual crops include cereals, potato, tobacco, tomato, cucumber and peanuts. Most of the farm holdings are small, fragmented and scattered, and are operated by their owners. About 20% of the land is handled by renters and share-croppers. It has been estimated that about 13.5% of the economically active population are involved in agriculture.

WEED PROBLEMS AND CROP LOSSES

Weeds compete with crops for water, nutrients, light, carbon dioxide and space without showing any alarming "epidemic" symptoms as other pests. For this reason, it has been very difficult to convince farmers, as well as professional agriculturists and government planners, as to the extent of crop losses due to weeds, since they are taken for granted.

Data on crop losses due to weeds are lacking in Lebanon and most parts of the Near East. In order to get accurate figures on losses, weed competition studies should be made on specific weeds of specific crops; otherwise all values reported on crop losses in literature are merely estimates on yield reductions due to weed competition.

Cereals are most sensitive to weed competition in their early stages of growth i.e. between the 3 and 6-leaf stage. Estimates of wheat losses due to weeds amount to 17% in Lebanon, 19% in North Africa, 20% in Turkey, 45% in Iraq and 30-80% in Jordan. In addition to causing crop losses, weeds harbour disease organisms and

insects, and interfere with harvesting operations, particularly in the case of climbing weeds such as Convolvulus arvensis which may cause lodging of cereals. Weed seeds of Avena, Cephalaria and Sinapis species, when mixed with wheat grains, result in dark coloured flour which becomes bitter and gives bad odour. Some weed contaminants may also cause a laxative effect when mixed with wheat flour.

Serious weed problems occur also in vegetable and field crops. Solanaceous and legume crops are infested with the noxious root parasitic weed Orobanche (broomrapes). Orobanche ramosa causes severe losses in the production of tomato, potato, tobacco and other host crops; whereas Orobanche crenata infests faba beans and other legumes.

Orchards are mostly infested with perennial weeds such as Cynodon dactylon, Cyperus rotundus and Sorghum halepense. The most prevalent annual weed in citrus plantations in Lebanon is Digitaria sanguinalis. In addition to these weeds, Echinochloa crus-galli causes problems in olive orchards.

NEW WEED PROBLEMS

With continuous use of herbicides for the control of broad-leaved weeds in various crops, particularly cereals, grass weeds are becoming a problem. One of the most serious weeds in cereals is Avena sterilis. Other grass weeds which are becoming established include Lolium and Phalaris spp. Original infestations of these weeds are suspected to have been introduced as contaminants with crop seeds. In areas where phenoxy herbicides have been used, tolerant broadleaved weeds, such as Anthemis and Polygonum species, are becoming a problem in cereal fields.

LEGISLATION FOR WEED CONTROL

At present, plant quarantine regulations concerning prevention of weeds from entering and infesting new areas in Lebanon are not established yet. It is important to legislate for a comprehensive seed law which requires certification of crop seeds that should restrict or completely prohibit the introduction of weed seeds. Parasitic weed species are considered as primary noxious weeds whose entry to the country should be completely prohibited. Secondary noxious weed seeds content may not exceed 0.5-1.0% of any crop seed; otherwise entry of the seeds should be prohibited. A new pesticide law has been established in Lebanon which regulates the importation and sale of pesticides including herbicides. Provisions are made

for preventing the sale of pesticides which are banned in the country of origin or proved to be hazardous.

WEED MANAGEMENT PRACTICES

Most of the weed control which is practised by the small scale farmer is carried out by handpulling and hoeing. Large scale farmers practise cultivation in row crops or orchards, and mechanical tillage in the fallow season in case of cereals. Few progressive farmers use herbicides in orchards, potato, corn and cereals. It is estimated that about 5-10% of the areas planted to cereals in the Near East are sprayed with herbicides. The most commonly available herbicides include phenoxy compounds, metribuzin, trifluralin, atrazine plus metolachlor, paraquat and glyphosate. These are used in cereals, potato, vegetable crops, corn and orchards, respectively. With the high conversion rate of the U.S. $: L.L. (1:16), prices of herbicides on the local market are becoming extremely high.

EXTENSION, TRAINING AND RESEARCH IN WEED CONTROL

The extension service at the Ministry of Agriculture is understaffed, and has not been functional since the beginning of the troubles in Lebanon in 1975. The extension agents are generalists, and do not have any specialization in weed control. As such their impact on improving weed management in the country has been minimal.

Training at the secondary school level is provided in four public agricultural vocational schools supervised by the Ministry of Agriculture. The objective of these schools is to provide technically skilled people in various disciplines of agriculture. Students enrolled at these vocational schools are exposed to limited training in weed management.

At present, the Faculty of Agricultural and Food Sciences (FAFS) at the American University of Beirut (A.U.B.), which is a private institution, provides training in both undergraduate and graduate level programs in the various disciplines of agriculture. The undergraduate curriculum includes a required course in weed science which covers at least 30 lectures and 15 laboratory sessions within one semester. In addition two post graduate courses are offered at A.U.B. The first covers the mode of action of herbicides, and the second surveys the development and progress in weed science, including proceedings of recent symposia and conferences, significant scientific papers and research reports, so that its topics are flexible and change from year to year.

It is hoped that the newly established Faculty of Agriculture at the Lebanese University, which is a public institution, will include in its curriculum an adequate program in weed management training.

Research in weed control in the public sector is very limited since there is no weed scientist appointed at the Agricultural Research Institute of the Ministry of Agriculture. However, another public agency which promotes agricultural research in Lebanon is the National Council for Scientific Research (NCSR). This agency appointed a weed researcher in 1980 and located him at the Faculty of Agricultural and Food Sciences at A.U.B. to work jointly with its weed science group. The NCSR allocates funds through grants deposited at A.U.B. to conduct this collaborative research program.

Private research in weed control is carried out mostly at A.U.B. and at the branch station of the International Center for Agricultural Research in Dry Areas (ICARDA) in Terbol, Beka'a. Weed Research in Lebanon was initiated at A.U.B. in 1959. About 80 different herbicides have been tested so far to determine their effects on weeds, and on the agronomic or horticultural characteristics and quality of several crops. These included studies on wheat, barley, corn, soybeans, sugarbeets, alfalfa, lentils faba beans, checkpeas, onions, tomato, potato, cucumber, citrus and olives. During the last 15 years studies concentrated on the biology and control of Orobanche (broomrapes), a parsitic plant which attacks solanaceous and legume crops. Work was conducted on interactions between host and parasite in relation to photosynthate translocation, anatomical relationships, effect of inoculum density of Orobanche seeds in soil, susceptibility of tomato cultivars to Orobanche, evaluation of the activities of synthetic germination stimulants, herbicides and various other chemicals for the control of this parasite. Some work has been initiated on the control of Cuscuta (dodder), a stem and leaf parasite on legume and several broadleaf species.

Weed control research at ICARDA is concentrated on problems in wheat, barley, faba beans, chickpeas and lentils. Few trials are also conducted by some chemical companies on the efficacy of herbicides in various crops.

LITERATURE ON WEED MANAGEMENT

The first survey of the flora of the Middle East was published by Dr. G.E. Post of the American University of Beirut in 1883-1896. With the establishment of the FAFS in 1952, Mrs Winnie Edgecombe

started a nation-wide survey of weeds in Lebanon, which were described and illustrated in three books published in 1959, 1964 and 1970. A total of 341 species belonging to 46 families were described in her last book entitled "Weeds of Lebanon". Another important document is the work of Pere Paule Mouterde of the Saint Joseph University of Beirut who described the flora of Lebanon and Syria in two volumes published in French. Literature pertaining to national weed control studies conducted by the author and co-workers is cited in the list of references.

CONCLUSIONS AND SUGGESTIONS FOR IMPROVEMENT OF WEED MANAGEMENT

Weed control is considered as one of the essential inputs necessary for maximizing crop production in Lebanon. With the improved growing conditions for crops, such as the use of fertilizers and irrigation, the weed problems often are intensified. This is because weeds are plants which happen to grow out of place, and as such respond-like crops-to improved growing conditions.

Handweeding commonly absorbs 20-50% of total crop production labor within tradional agriculture. With the unavailability of labor and their increasing cost in Lebanon and the Near East, there is a trend in the region toward the use of chemical weed control inspite of the increasing costs of herbicides on the local market.

Improved weed management in Lebanon and the Near East develop as a result of weed research conducted in the region at private and public universities and government research centers. Such efforts should focus on the following areas:

1. Weed surveys should be conducted in the region, and efforts should be concentrated on studying the biology and control of special weed problems including perennial noxious weeds such as Cyperus, grass weeds such as Avena, and parasitic weeds such as Orobanche, Cuscuta and Striga.
2. Since new herbicides are expensive, regional research should stress the use of already existing cheap herbicides by developing antidotes and formulation additives which protect the crop and improve the selectivity of these herbicides.
3. Work should be conducted on the use of simple application techniques such as granular formulations, or mixing herbicides with fertilizers as "herbilizers" in order to cut down on the cost of application.
4. There is a need for an integrated approach in studying weed-crop interactions, soil and environmental factors involved, as well as sociological studies on the impact of herbicide use in crop production. This should be a part of an overall study of an

integrated pest management program.

5. Research should be made on tillage practices, crop rotations, row distances and plant densities in relation to weed-free situations.

In order to implement these research programs to meet the future needs of the region, encouragement should be made to include weed science as a recognized discipline in universities, research institutes, ministries of agriculture and international centers and organizations; and to include training and research in weed science in the list of priorities for agricultural planning at the national level.

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WEED MANAGEMENT: COUNTRY STATUS PAPER - MOROCCO

M. Mouch
Direction de la Protection des Vegetaux
B.P. 415, Rabat, Maroc

INTRODUCTION

Une grande importance a été accordée au développement de la malherbologie dans les pays avancés pour réduire les pertes en rendement dûes aux adventices. Des programmes ont été établis dans le domaine de la recherche, du développement des infrastructures, de la vulgarisation et de la formation, et en conséquence une réduction considérable des pertes de récolte a été atteinte. Malheureusement, rien de cela n'est fait dans les pays en développement où des pertes énormes de la production alimentaire allant jusqu'a 100% ont été rapportées. Cette situation alarmante a retenu l'attention des organisateurs de cette consultation dont les objectifs sont:

- d'une part, évaluer les possibilités des pays membres en matière de malherbologie.
- d'autre part, développer un programme d'action national et régional pour développer la malherbologie dans le court et long terme.

Le plan suivi dans la rédaction de ce rapport est celui recommandé par les organisateurs dont la succession des points a été entièrement respectée.

ABBREVIATIONS

AMM	:	Association Marocaine de Malherbologie
CEB	:	Commission des Essais Biologiques
CEE	:	Communauté Economique Européenne
DPA	:	Direction Provinciale de l'Agriculture
DPVCTRF	:	Direction de la Protection des Végétaux des Contrôles Techniques et de la Répression des Fraudes.
ENA	:	Ecole Nationale d'Agriculture
EWRS	:	European Weed Research Society
FAO	:	Food and Agriculture Organization of the United Nations.
GTZ	:	Deutsche Gesellschaft für technische Zusammenarbeit
INRA	:	Institut National de la Recherche Agronomique Maroc
INAV	:	Institut National Agronomique et Vétérinaire Hassan II
IRPV	:	Inspection Régionale de la Protéction des Végétaux
IWSS	:	International Weed Science Society
MARA	:	Ministère de l'Agriculture et de la Réforme Agraire

OEPP : Organisation Europeenne de la Protéction des Plantes.
ORMV : Office Régional de Mise en Valeur.
UNDP : United Nations Devslopment Program.

INFORMATIONS SUR L'AGRICULTURE MAROCAINE

Le Maroc est un grand pays d'environ 700,000 km^2 et comptant 22,000,000 d'habitants. Situé a l'extrémité occidentale du couchant et ouvert à la fois sur la mediterranés et l'Ocean atlantique, il a une très forte personnalité, plaines et plateaux couvrent de vastes surfaces, fait inhabituel dans les pays voisins, tandis que de majsstueuses montagnes s'élèvent jusqu'a 4000 m d'altitude. Grâce à sa façads atlantique l'exposant aux vents d'Ouest, le Maroc est le pays le plus humide de l'Afrique du Nord, où les influences arides du Sahara sont rejetées loin vers le Sud, au moins dans les régions littorales. Topographie et pluviosité expliquent la longueur et l'abondance des cours d'eau dont plusieurs ont fait l'objet d'importants aménagements hydrauliques psrmettant ainsi la création de 9 périmètres irrigués.

La part du territoire utilisée par l'Agriculture représente 42% ds la supsrficie du pays (Tableau I). La superficie agricole utile (SAU) s'élève à 27,8% des terres utilisées par l'Agricultsrs, dont presque la totalité est représentée par les terres labourables (Tableau II). La superficis consacrée aux céréales couvre 4,477,600 ha, soit 60% des terres labourables (Tablsau III).

Le potentiel national irrigable est de 1,218,568 ha dont ssuls 754,432 sont irrigués actuellement, soit un taux d'exploitation de 62% environ ce qui représente 9,4% de la SAU. Ce sont surtout les cultures industrielles (Betterave à sucre, canne à sucre, coton), les spéculations dsstinées à l'exportation (Agrumes, cultures maraîchères et primeurs) et certaines cultures fourragères qui bénéficient de l'irrigation.

La production céréalière est déficitaire depuis 1960. Les besoins sont évalués à environ 60 millions ds quintaux pour les 4 principales céréales (blé dur, blé tendre, orge et mais) alors que la production annuelle moyenne ne dépasse pas 40 millions de quintaux et reste caractérisée par des rendements très bas (Tablsau III). Les 4 dernières années ont été marquées par une séchsresss sxceptionnelle, ce qui à fait chutsr la production a 20.2 millions de quintaux en 1981. La meilleure performance reste celle de la compagne de 1976 avec 56.5 millions de quintaux.

LE PROBLEME DES MAUVAISES HERBES

Avec près de 45000 espèces et sous-espèces de végétaux vasculaires répartis en 920 genres et 124 familles pour une superficie d' environ 7000,000 km^2, le Maroc est un des pays méditerranéens occidentaux dont la flore est une des plus riches et des plus diversifiées. La richesse aréale rapportée à 1000 km^2 est de 6.4 (9.3 avec l'ancienne superficie, la végétation des provinces du Sud n'etant pas encore recensée). A titre de comparaison, la France compte : 8, Espagne : 11, Italie: 12.9 Suisse : 62.6 Monde : 2.

Ces espèces phanérogammes constituent les différentes formations végétales marocaines (forêts, pelouse, prairies, fermes ...) et un certain numbre d'entre elles compose la flore adventice marocaine. Bien qu'il n'y ait pas d'inventaire exhaustif pour tout le pays, on peut estimer le nombre de ces adventices à quelques centaines d'espèces (entre 500 et 1000 peut être), auquel il faut ajouter celui des espèces toxiques connues, lui même difficile à fixer. 805 espèces (ou sous-espèces) sont endémiques, soit près de 20% de la flore totale, ceci s'explique en particulier par l'existence de barrières montagneuses et de bassins fermés ou isolés. La famille des crucifères renferme à elle seule 7 genres spéciaux, d'où des difficultés sérieuses de détermination.

Parmi les espèces adventices, certaines sont bien connues pour leur concurrence particulierement agressive vis à vis des cultures. D'autres sont toxiques pour le bétail: Ferula communis, Ricinus communis, Nerium oleander, Ononis serotina ssp. pseudoserotina, Lathyrus spp. Anthoxanthum odoratum, Stipa retorta, Solanum nigrum, Coronilla scorpioides ...

De tous les temps les agriculteurs ont combattu les adventices et essayé de rendre propre leurs champs. Les mauvaises herbes sont également utilisées pour servir d'aliment au bétail. Mais contrairement aux dégâts spectaculaires engendrés par les ravageurs animaux ou certaines maladies, les pertes de rendement occasionnées par les mauvaises herbes sont moins visuelles et suscitent de ce fait moins de réaction de la part des agriculteurs. Cependant on peut citer quelques exceptions: cas d'infestation importante (folle avoine dans les céréales) ou anéantissement de la récolte des légumineuses par l'orobanche par example.

Nulle en 1960, la production du sucre n'a cessé de progresser depuis pour atteindre 427,200 tonnes en 1983, soit 68% des besoins du pays, où la betterave intervient pour 83%.

La production d'huiles végétales reste elle aussi déficitaire puisqu'elle ne couvre avec ses 36,000 tonnes que 17.5% de la

consommation du pays.

L'Agriculture engage de manière directe ou indirecte 57% de la population. La propriété privée (Melk) est le statut juridique dominant des exploitations et concerne 74.5% des terres, suivi de loin du régime collectif avec 18%. La repartition des exploitations selon leur taille fait ressortir que 80% d'entre elles ont une superficie inférieure à 5 ha (Tableau IV).

Ce n'est que vers le début des années 70 que les milieux officiels ont commencé à se pencher de plus en plus sur ce problème, avec la création du laboratoire de Malherbologie à la Direction de la Recherche Agronomique et la dispense des premiers course sur les adventices au niveau de l'enseignement agronomique. L'extension des surfaces céréalières réservée à la multiplication des semences sélectionnées et la nécessité d'éviter la contamination des lots produits par des semences étrangères a contribué aussi à une meilleure prise de conscience dans ce domaine. Il faut signaler par ailleurs que les herbicides anti-folle avoine sont subventionnés et que la lutte chimique contr l'orobanche des fèves fait l'objet de spots publicitaires à la télévision. Neanmoins il reste beaucoup d'efforts à entreprendre pour que la malherbologie soit considérée comme une discipline à part entière au même titre que l'entomologie ou la phytopathologie par exemple.

ESTIMATION DES PERTES EN RECOLTE DUES AUX MAUVAISES HERBES

Ce genre d'estimation n'est pour le moment pas disponible et il n'y a, à notre connaissance, aucune étude qui a été faite dans ce sens.

Dans le cas de l'orobanche des fèves, Schmitt, a indiqué qu'en 1979 les pertes de rendement dûes à ce phanérogamme parasite étaient de 12% pour tout le Maroc et variaient de 2.3 à 25.2% selon les régions. Cette perte moyenne représentait à l'epoque 36.9 millions de DH (soit environ 9 millions de dollars US de 1979).

TECHNIQUES CULTURALES CHEZ LES PETITS ET LES GRANDS AGRICULTEURS

L'économie agricole marocaine se caractérise par la coexistence de 3 secteurs largement différenciés:

- Secteur modern: occupe près de 2% des terres cultivées, soit environ 2 millions ha. Il est constitué par des exploitations viables souvent de bonnes terres, mécanieées et équilibrées du point de vue de leur rentabilité. Ce secteur utilise des moyens techniques modernes et s'oriente vers l'économie de marché.

- Secteur traditionnel viable: formé en principe de grandee et moyennes exploitations dont l'importance de superficie compense les faibles rendements. Lee moyens de travail y sont rudimentaires et les techniques culturales extensives. L'équipement et la mise en valeur de ce secteur est une question d'organisation et de moyens financiers.

- Secteur traditionnel marginal: groupe la majorité dee payeans. Leurs exploitations exigues et émiettées, de type familial, donnent naissance à une économie de subsistance en dehors de normes de rentabilité. C'est ce secteur qui pose l'essentiel du probleme du développement agricole.

Aueei bien pour les petits que pour lee grands propriétaires, la compagne agricole commence avec les premières pluies. Il n'est fait exception à cette règle que si l'exploitation dispose de puissants tracteurs et de sols légers car la période de eécheresee estivale rend tout travail précoce du sol pratiquement impossible pour un attelage ou des machines légères. Les labours sont en général superficiels, réalisés à l'aide d'une charrue sarcleuse (attelage animal) ou d'une charrue à disquee (cover-crop/tracteur). De ce fait, très peu d'agriculteurs réalisent des labours profonds.

Si l'emploi dee engrais est courant, c'est surtout l'azote qui est trèe utilisé, l'usage dee engrais phosphatés et en particulier potassiquee est relativement moins répandu. La commercialisation, sans ceese croissante cee dernières années, de composée NPK est de nature à combler cette lacune. Les cultures bénéficiaires eont en général lee spéculations de rapport: cultures industrielles (Betterave et canne à sucre, coton), plantations d'agrumes, primeurs et maraichage. L'épandage du fumier est couramment pratiqué dans les culturee saclées, notamment dans lee culturee maraichèree. On déplore cependant que les dosee d'engrais effectivement utilisées soient en deça de celles recommandéee, ceci eet particulièrement vrai en exploitation extensive (céréaliculture), et surtout que l'usage dee oligo-élémente fasse entièrement défaut.

Toue les syetèmes d'irrigation peuvent être rencontrée au Maroc: par épandage (Flusch-irrigation, par exemple dans les culturee dérobées du Sud du pays); par ruiseelement ou déversement (Wild flooding); irrigation à la planche au calant (Border-cheek-irrigation); par bassins ou par cuvettes; par aspersion; au goutte à goutte (Drip irrigation). Néanmoins c'est l'irrigation à la raie (par déversement) ou à la planche qui est tradition-

nellement la plus pratiquée.

Le secteur moderne utilise depuis plusieurs années aussi l'aspersion, au moment où le système du goutte à goutte connait de l'extension, vu l'économie d'eau qu'il réalise, combien appréciée dans les conditions de l'agriculture marocaine.

La récolte des céréales, des fourrages et des légumineuses destinées a l'alimentation du bétail est entièrement mécanisée dans les exploitations modernes. L'usage de la moissonneuse-batteuse est courant aussi dans le secteur traditionnel viable, tandis que la faucille supplée à la machine pour la moisson des petits lopins et des emblavures en terrain accidenté. Vu l'abondance de la main d'oeuvre encore bon marché, la récolte de toutes les autres cultures et plantations se fait à la main.

PRINCIPALES MAUVAISES HERBES DES CULTURES

Un inventaire des principales adventices fréquemment rencontrées dans les champs de céréaliculture et de légumineuses figure en Annexe I. Des études basées sur la multiplication des relevés de mauvaises herbes par culture et dans différentes régions productives du pays ont déjà commencé et vont permettre à l'avenir, si elles sont eucouragées, d'avoir des connaissances précieuses sur la flore adventice.

Voici résumé dans ce qui suit les principales espèces phanérogammes posant des problèmes spécifiques.

Adventices des céréales:

L'évolution du désherbage chimique a conduit à une sélection d'espèces résistantes d'abord au 2,4-D (folles-avoines, notamment Avena sterilis ssp, macrocarpa) puis aux antigraminées spécifiques des folles-avoines tels que le benzoypropethyl (Lolium spp., Phalaris spp.) et actuellement aux antigraminées à plus large spectre d'action comme le diclofop-methyl (Bromus rigidus, Bromus sterilis, Bromus mollis) surtout dans la région de Meknès et les zones irriguées du Gharb.

Plusieurs dicotylédones infestent fortement et localement les champs de céréales:

- Astragalus baeticus: espèce importante dans la région de Meknès, difficile à éliminer au conditionnement des semences et dont le taux de diaspores dans les semences certifiées de 2 ème reproduction ne doit pas dépasser 40 dans 1000 g.

- Thesium humile: espèce hémiparasite du blé dans les sols pauvres. Elle est devenue inquiétante dans la région de Safi.

Toxique pour le bétail.

- Galium tricorne et Convolvulus arvensis: mauvaises herbes grimpante résistantes au 2,4-D.

Dans les rizières du Gharb, le problème majeur est représenté par les panics: Echinochloa crus-galli (= Panicum crus-galli), qui infeste aussi les champs de sorgho et de maïs.

- Orobanche des légumineuses: Orobanche crenata

Ce phanérogamme parasite plusieurs cultures: fèves, feveroles, petitpois, lentilles et même les carottes. Les pois-chiches lui semblent résistantes. Il a fait l'objet d'une étude détaillée (19), avec la mise au point d'une méthode de lutte chimique dans le cas des fèves (voir plus loin).

- Roseaux et massette:

Les roseaux (Phramites communis) sont devenus très abondants dans les cultures irriguées de blé et de riz. Ils envahissent avec la massette (Typha angustifolia) les canaux d'irrigation surtout dans le Gharb et le Tadla.

- Cuscute:

Diverses infestations sur oliviers (Er-Rachidia), sur agrumes (Souss), sur tomate, sur luzerne ... sont signalées. Plusieurs espèces sont présentes dont la systématique mérite d'être mise au point.

- Espèces vivaces:

- Dans les vergers c'est surtout Cynodon dactylon et Cyperus rotundus qui, profitant de l'irrigation, sont capables de développer des colonies importantes.

- Oxalis cernua, dans les cultures maraicheres et les pépinières.

- Le jujubier Zizyphus lotus avec ses buissons fortement ramifiés et très épineux et sa souche très puissante peut rendre incultes de grandes surfaces.

NOUVEAUX PROBLEMES DE MAUVAISES HERBES

C'est en 1980 qu'est apparu d'une manière à la fois soudaine et spectaculaire une solanacée dans les surfaces emblavées de coton dans la région du Tadla. Il s'agit de Solanum elaeagnifolium, capable de se multiplier aussi bien par voie générative que végétative et qui s'est étendue maintenant aux céréales et à d'autres cultures annuelles ou perennes.

Bien que rien de certain n'est connu sur l'origine de cette infestation subite, les semences importées pourraient bien avoir été un mode d'introduction de cette mauvaise herbe.

LEGISLATION CONCERNANT LE DESHERBAGE

Il n'y a pas de législation particulière à la lutte contre les mauvaises herbes. La réglementation des herbicides fait partie de celle régissant les pesticides agricoles en général. Il ne peut être commercialisé ou utilisé, qu'un pesticide ayant fait l'objet d'une autorisation préalable. Les demandes d'homologation sont faites au Bureau des Pesticides et de l'Homologation de la Direction de la Protection des Végétaux des Contrôles Techniques et de la Repression des Fraudes qui est chargée de l'étude des dossiers sous ses aspects techniques et administratifs. Ce bureau s'occupe egalement des expérimentatione herbicides avec les Inspectione Régionales de la Protection des Végétaux, à qui sont envoyés les protocoles d'essais élaborés selon les méthodes internationales de la C.E.B. et de l'O.E.P.P.

Sur environ 200 molécules pesticides et 1300 spécialités homologuées, les herbicides comptent 63 molécules correspondant à 194 spécialités.

METHODES DE LUTTE CONTRE LES ADVENTICES

Desherbage manuel:

L'agriculteur marocain utilise très souvent les mauvaises herbes comme fourrage. Il doit choisire, en effet, entre: perte des mauvaises herbes + augmentation éventuelle du rendement et utilisation de celles-ci + diminution du rendement. Il peut aussi, sous certaines conditions, ne pas avoir le choix.

Pour se débarasser des adventices, on a recours traditionnellement au desherbage manuel. C'est la technique la plus ancienne, qui se pratique à l'aide d'outils plus ou moins appropriés: binettes et sapes. De temps en temps les ouvriers peuvent arracher les herbes à la main même, surtout si le sol n'est pas trop sec, ce qui facilite l'extirpation des racines.

C'est le mode de desherbage le plus répandu dans les cultures annuelles et sarclées: légumineuses, betterave sucrière, coton, cultures maraichères et pépinières. L'opération peut commencer au moment ou la distinction entre adventices et culture devient aisée pour ne pas endommager cette dernière, au moment du démariage par exemple pour la betterave à sucre. En céréaliculture, les mauvaises herbes sont ramassees et données au bétail à un stade très

avancé de la céréale, au moins après fin-tallage.

Le desherbage manuel d'un hectare de betteraves nécessite de 20 à 25 journées de travail. Autrement dit, 20 a 25 cuvriers sont necessaires pour desherber manuellement un hectare par jour. Lorsqu'il faut realiser en meme temps la reconfection des billons d'irrigation, cela demande 40 a 45 journees (9). Quatre interventions sont generalement necessaires.

Desherbage mecanique:

Il est réalisé avec des outils utilisant la traction animale, très rarement un tracteur. Les outils employés sont la charrue à disque ou à soc ou des outils à dents ayant une largeur de travail allant de 20 à 40 cm. Ce sont encore les légumineuses et autres cultures sarclées qui bénéficient de cette technique.

Le binage mécanique (traction animale) d'un hectare de betteraves par exemple demande 1 à 2 journées de travail selon l'infestation et l'état du sol. La traction mecanique à l'aide d'un tracteur permet un travail plue rapide: avec un passage réalisant un travail de 3 à 4m de largeur, 5 ha peuvent être désherbés par jour (Link & Mouch, 1983).

Desherbage chimique:

En céréaliculture, l'emploi des acides phenoxyacétiques (2,4-D ou 2,4 MCPA ou une aseociation des deux) contre les dicotylédones est de plus en plus fréquent dans les grandes parcelles du secteur moderne et même du secteur traditionnel viable, en particulier dans les emblavures destinées à la multiplication des semences. Lee infeetations massives de l'avoine stérile ont fait également recourir à l'utilisation des herbicides anti-folles-avoines, d'ailleurs subventionnes, comme le benzoylpropethyl.

Malgré une expérience de plusieurs années d'essais de desherbage chimique des betteraves à sucre soldée par des résultats positifs, l'emploi des desherbants (Phenmédiphame, lénacile, pyrazone..) reste limité à quelques grands domaines et aux fermes de l'Etat.

Les essais de désherbage chimique du coton, notamment dans le périmètre irrigué du Tadla, n'ont pratiquement pas dépassé le stade de démonstration. De même que ceux entrepris pour lutter contre les adventices vivaces (Cyperus rotundus, Cynodon dactylon ...) dans les plantations d'agrumes en particulier.

Par contre les agriculteurs se sont beaucoup intéressés à la lutte chimique contre l'orobanche des fèves à l'aide du glyphosate. De plus en plus de cultivateurs optent pour cette voie chimique qui constitue, pour le moment, la seule solution efficace pour combattre

cette plante parasite aux dégâts spectaculaires.

VULGARISATION

Il est difficile de chiffrer la part du désherbage chimique à l'échelon national. Même au niveau régional les statistiques relatives aux superficies désherbées chimiquement font également défaut. En cas d'emploi d'herbicides, il n'est par rare de constater le mauvais choix de produits et surtout leur mauvaise application.

Compte tenu de ce qui précède et des problèmes posés par les mauvaises herbes dans plusieurs cultures et sous différents aspects, on voit le rôle que la vulgarisation de la lutte contre les adventices a à jouer et l'importance qu'elle doit revêtir. Malheureusement les bureaux de vulgarisation au niveau des Directions Provinciales de l'Agriculture ou ceux travaillant dans le cadre des Offices Régionaux de Mise en Valeur ne se préoccupent pratiquement pas des questions de desherbage.

Deux problèmes importants retiennent cependant l'attention du Ministère de l'Agriculture et de la Réforme Agraire: l'orobanche des fèves et la folle avoine dans les céréales. Le procédé chimique de lutte contre ces deux plantes, respectivement à l'aide du glyphosate et du benzoylpropethyl, fait l'objet de spots de vulgarisation à la télévision et parfois aussi d'émissions radiophoniques. Des affiches posters leur sont également réservées dans les organismes de l'Agriculture, de même que des annonces publicitaires dans les journaux. Inutile de rappeler que les antifolles avoines (Benzoylpropethyl, Dichlofop-methyl) sont subventionnés par l'Etat et que les dégâts causés par l'orobanche et la folle avoine n'ont d'égal que l'impuissance des agriculteurs devant ces problèmes, privilégiés, à juste titre d'ailleurs, par pouvoirs publics.

FORMATION

Comme il n'y a pas de vulgarisation de désherbage que ce soit au niveau des Directions Provinciales de l'Agriculture, des Offices Régionaux de la Mise en Valeur Agricole ou même des Inspections Régionales de la Protection des Végétaux, il n'y a pas non plus de programmes de formation d'instructeurs dans ce domaine.

Depuis la moitié des années 70, des cours de Malherbologie ont commence à être dispensés à l'Institut Agronomique et Vétérinaire Hassan II de Rabat, à l'Ecole Nationale de l'Agriculture de Meknès et aussi à l'Ecole d'Horticulture et de Phytiatrie

d'Agadir. Les enseignants de botanique y voient une revalorisation de leur matière qui souffre d'un désintéressement quasihabituel de la part des étudiants et pour qui la malherbologie constitue désormais un terrain d'application pratique et extrêmement intéressant. L'enseignement comprend des séances de systématique des végétaux, des sorties et des travaux pratiques. Dans la cadre de stages, les étudiants doivent s'intéresser aux problèmes de désherbage.

ACCES DES AGRICULTEURS AUX PRODUITS HERBICIDES

Il n'y a jamais eu de problèmes d'approvisionnement en herbicides. Toutes les matières actives et spécialités homologuées sont disponibles chez les sociétés de produits chimiques basées à Casablanca et qui approvisionnent régulièrement les fournisseurs et concessionnaires régionaux.

Les applications se font en général à l'aide d'un pulvérisateur à dos. Très peu d'exploitations disposent d'un grand appareil avec rampe de pulvérisation. On reproche aux traitements d'être assez souvent mal faits: pulvérisateur à dos défectueux, doses non respectées, buses non appropriées, application faite par des personnes non exercées, parfois même par des enfants.

RECHERCHE EN MALHERBOLOGIE

Place de la malherbologie à la D.P.V.C.T.R.F.:

La Direction de la Protection des Végétaux des Contrôles Techniques et de la Repression des Fraudes, créée depuis 1980 et anciennement faisant partie de la Direction de la Recherche Agronomique, sauf en ce qui concerne la repression des fraudes, comprend deux divisions, celle de la Repression des Fraudes et celle de la Protection des Végétaux et du Contrôle Technique. Cette dernière compte deux services: le Service de la Protection des Végétaux et de la Lutte Antiacridienne et le Service du Contrôle Technique des Semences et des Plants.

Le premier service se compose d'un Service Central à Rabat et de 22 Inspections Régionales de la Protection des Végétaux.

Le Service Central est constitué de cinq bureaux:

- Le Bureau des Pesticides et de l'Homologation, qui aborde la lutte contre les mauvaises herbes dans le cadre de l'utilisation et de l'homologation des herbicides sous ses aspects techniques et

administratifs. Ce bureau a repris à la Direction de la Recherche Agronomique l'étude des dossiers d'homologation depuis sa création en 1979. Il s'occupe aussi des expérimentations herbicides avec les Inspections Régionales de la Protection des Végétaux à qui sont envoyés les protocoles d'expérimentation élaborés conformément aux méthodes internationales de la C.E.B. et de l'O.E.P.P.

- Le Bureau des Contrôles Phytosanitaires (Contrôles phytosanitaires, réglementations Import/Export).

- Le Bureau des Grandes Luttes (lutte antiacridienne, lutte antiaviaire, lutte antirongeurs....).

- Le Bureau des Avertissements Agricoles et de la Vulgarisation, qui rédige et édite les Bulletins Phytosanitaires dont certains concernant le désherbage des céréales.

- Le Bureau de Coordination, qui fait circuler l'information entre tous les Bureaux.

Il n'y a donc pas de laboratoire de Malherbologie au niveau central et hormis leur contribution au déroulement des essais herbicides, les activités des Inspections Régionales de la Protection des Végétaux en la matière sont pratiquement nulles. Sans doute cela est dû au manque de cadres, puisque la Direction de la Protection des Végétaux des Contrôles Techniques et de la Repression des Fraudes ne compte à une exception près aucun malherbologue.

Le personnel de chaque Inspection Régionale de la Protection des Végétaux varie selon l'importance de l'Inspection, mais chaque Inspection possede son laboratoire. Ainsi à l'Inspection Régionale de la Protection des Végétaux de Sidi Kacem travaillent trois ingénieurs dont l'Inspecteur, l'auteur de ce rapport qui est malherbologue, et quatre adjoints techniques. Malgre l'équipement dérisoire (pas de serre, ni de halle de végétation ...) et l'absence totale de bibliographie (pas d'ouvrages de base pour la détermination de la flore par exemple) des efforts sont entrepris au niveau de cette Inspection pour développer cette discipline (relevés de la végétation adventice par culture, enquête sur le désherbage, essais de concurrence, lancement d'avertissements agricoles: orobanche et folle-avoine,....).

L'étude sur l'orobanche des fèves a commencé au temps de la Direction de la Recherche Agronomique dans le cadre d'un projet allemand, la Direction de la Protection des Végétaux des Contrôles Techniques et de la Repression des Fraudes s'est chargée par la suite de la vulgarisation de la méthode de lutte contre ce parasite par l'intermédiaire des Inspections Régionales de la Protection

des Végétaux en procedant à des démonstrations chez les agriculteurs. La même procédure a été suivie pour vulgariser la lutte anti-folle avoine.

C'est le Service de la Protection des Végétaux qui a organisé les Premières Journées Nationales de Malherbologie en 1979 à El Jadida d'où a émergé l'idée de création de l'Association Marocaine de Malherbologie (AMM) qui a tenu son premier séminaire en 1982 à l'Ecole Nationale de l'Agriculture de Meknès.

Activités de recherche en Malherbologie à l'Institut National de la Recherche Agronomique:

La Station Centrale de Phytiatrie à Rabat comprend plusieurs laboratoires dont un est consacré à la Malherbologie. Celui-ci a été crée en 1975 (l'auteur de ce rapport était le premier ingénieur qui l'a dirigé) et compte actuellement deux ingénieurs et deux adjoints techniques. Les premières tâches confiées à ce laboratoire concernaient l'expérimentation herbicide qui allait avant 1979 jusqu'à l'homologation des produits dans les cultures de céréales, betterave à sucre, légumineuses alimentaires et pomme de terre. Depuis 1980 ce laboratoire s'interesse aussi à la bioecologie, et l'étude des groupements d'adventices des cultures.

L'Institut National de la Recherche Agronomique compte également un ingénieur travaillant sur les mauvaises herbes dans la région de Settat dans le cadre du Projet Aridoculture. L'I.N.R.A. dispose en outre de fermes expérimentatales spécialisées: agrumes (El Menzeh) coton (Afourer), céréales (Sidi Kacem), riz (Sidi Allal Tazi), canne à sucre (Moghrane) ... où il est possible de procéder avec le concours des ingénieurs locaux à des essais de désherbage.

Recherche en malherbologie à l'Institut Agronomique et Vétérinaire Hassan II:

L'enseignement de la malherbologie relève du Département d'Ecologie Végétale et de Pastoralisme qui comprend plusieurs laboratoires dont celui d'Ecologie, d'Ecophysiologie et de Malherbologie. Parallèlement aux travaux d'enseignement, des activités de recherche sont entreprises et portent sur les points suivants:

- aspects écologiques des mauvaises herbes à propos de la description des communautés végétales du Maroc atlantique.
- aspects systématiques et taxonomiques.
- aspects floristiques par l'étude des flores adventices de certaines cultures (Betterave à sucre, riz, céréales).

L'Ecole Nationale de l'Agriculture de Meknès s'occupe aussi de l'écologie des mauvaises herbes et de l'étude de la flore adventice

des céréales.

Une partie de ces travaux est confiée aux étudiants dans le cadre de la réalisation de leur mémoire de fin d'études.

LITTERATURE SUR LA MALHERBOLOGIE

Les revues nécessaires à l'information scientifique des chercheurs comme Weed Abstracts, Weed Science, Weed Research... ne sont pas disponibles. On deplore même au niveau de certains services, pourtant concernés par la malherbologie, l'inexistence de toute flore pour la détermination des espèces de plantes.

La bibliographe nationale se résume en des articles parus à l'occasion de séminaires ou de journées d'études. Il n'y a pas de revue spécialisée. Les meilleures contributions ont été faites dans le cadre de mémoires de fin d'études ou de thèses de doctorat (cf. Annexe II).

CONCLUSIONS ET SUGGESTIONS

Remarques préliminaires:

Malgré la jeunesse du projet malherbologique dans le pays et en dépit des moyens parfois très modestes mis à la disposition des chercheurs, des efforts sont entrepris en vue d'être à la hauteur des problemes posés à l'Agriculture marocaine dans ce domaine et de donner par la même occasion aux applications de la Malherbologie l'écho qu'elles méritent. Il faut souligner à ce propos l'apport précieux de travaux anciens, surtout d'étude de la flore du Maroc en général, dont bénéficient les études actuelles.

A la lecture de ce qui a été dit précédemment, les problèmes de lutte contre les mauvaises herbes peuvent être ramenés à trois catégories:

- adventices localement importantes contre lesquelles il n'existe pas encore de solution chimique: bromes dans les céréales, cuscute dans diverses cultures, orobanche des légumineuses alimentaires autres que la fève.
- descherbage de cultures pour lesquelles la technique d'application des herbicides n'est pas encore maitrisée et les effets des produits encoure peu connus dans les conditions marocaines: riz, canne à sucre, colza.
- lutte contre certaines espèces récemment introduites en milieu méditérraneen (Solanum elaeagnifolium) ou localement importantes (Astragalus baeticus, Thesium humile, Phragmites communis).

D'autres problèmes peuvent être soulevés, mais il s'agit généralement de problèmes techniques résolus au stade expérimental mais dont la solution est encore peu ou pas vulgarisée dans la pratique: dicotylédones de la betterave à sucre, graminées des céréales, lutte contre certaines mauvaises herbes vivaces (Oxalis cernua, Ziziphus lotus, Lepidium draba ...).

Recommendations:

La plupart de ces recommandations ont été discutées lors du passage de J.P. Caussanel en 1982 et reproduites dans son rapport sur le désherbage des blés non irrigués au Maroc, consultation faite à l'instigation du Programme d'Action FAO/UNDP pour l'Amélioration de la Protection des Plantes.

Biologie, écologie et systématique des mauvaises herbes:

a) Pour la détermination des espèces de la flore marocaine, on se sert généralement des documents suivants:

- "Flora d'Afrique du Nord" de R. Maire (14 tomes sur 20 prévus): bon outil de travail, mais incomplet, car inachevé. Ainsi un certain nombre de familles ne sont pas traitées: Composées, Papilionacées, Labiées, Solanacées, Scrofulariacées ...
- "Catalogue des Plantes du Maroc" de E. Jahndiez et R. Maire (3 tomes + additifs): décrit pour chaque espèce son écologie et sa répartition au Maroc. Présente néanmoins des lacunes. Plusieurs especes ont été décrites à partir de specimens européens.
- "Novelle flore d'Algérie et des régions désertiques méridionales" de P.Quezel et S.Santa (2 tomes): beaucoup s'en servent car elle a l'avantage d'être pratique. Cependant plusieurs espèces marocaines, sans compter les endémiques, n'y figurent pas.
- "Petite flore des régions arides du Maroc occidental" de R. Negré (2 tomes): utile mais d'application limitée.
- "Flore du Maroc analytique, descriptive et illustrée" de CH. Sauvage et J. Vindt (2 tomes): traite un certain nombre de failles non décrites dans l'ouvrage de Maire.

D'autres travaux anciens pourraient être cités, mais une flore pratique du Maroc n'existe pas et il est de plus en plus nécéssaire et indispensable, de combler cette lacune. Un tel travail pourrait être réalisé dans le cadre d'un projet international avec la participation de spécialistes de la flore méditérraneenne et particulièrement marocaine et recevoir le concours de tous les organismes intéressés.

b) En ce qui concerne les adventices, il n'existe pas non plus d'ouvrage marocain complet. Des inventaires régionaux de mauvaises herbes ont été réalisés depuis quelques années et il est utile de poursuivre ces inventaires en faisant participer tous les services compétents (INRA, INAV, DPVCTRF, ENA), ce qui permettrait d'avoir des listes complètes d'espèces par région et par culture. Ce travail doit être encouragé scientifiquement et financièrement, le but étant la réalisation d'une brochure illustrée permettant la reconnaissance et l'identification des mauvaises herbes des cultures marocaines. Cette brochure pourrait être réalisée sous la responsabilite d'un organisme compétent par un groupe de travail issu de l'AMM sur la base des propositions d'un spécialiste de la flore adventice méditerranéenne.

c) Des liens étroits doivent être maintenus entre recherche et vulgarisation. Il est conseillé de développer les études de pertes de rendement dûes aux mauvoises herbes pour pouvoir convaincre les agriculteurs et avoir aussi une idée sur le comportement régional des herbicides homologués. Un grand effort doit être fourni aussi dans l'élaboration des dispositifs expérimentaux pour l'étude des seuils de nuisibilité.

Essais herbicides pour homologation:

Pour une meilleure exploitation des essais menés par les Inspections Régionales de la Protection des Végétaux et pour pouvoir comparer plusieurs essais de même nature entre eux, il est nécessaire à ce que les résultats présentés comporten aussi ceux des notations de recouvrement, d'efficacité et de phytotoxicité faites selon les échelles internationales habituellement adoptées (EWRS, CEB, OEPP). A ces échelles peut être ajoutée l'échelle 1 à 5 pour l'évaluation de l'abondance des espèces adventices, méthode préférable à celle des comptages dans des carrés de 1m2 et qui est souvent utilisée pour les relevés de la flore adventice.

Il importe aussi de répéter le même protocole d'essai dans le temps (pendant 3 ou 2 périodes végétatives au moins) et dans l'espace (sur 3 emplacements différents chaque année).

Contrôle des semences et plants:

Pourquoi certaines adventices des cultures particulierement "agressives" ne font-elles pas l'objet de mesures de quarantaine? Dans ce contexte, il serait utile d'introduire parmi les parasites de quarantaine au moins la cuscute et l'orobanche.

Compte tenu de la proximite du Maroc de l'Europe et du volume

considérable de ses échanges avec les pays de la CEE en particulier, il serait logique d'uniformiser progressivement les normes de teneur en semences de mauvaises herbes des semences certifiées de blé avec les normes européennes et d'encourager le désherbage chimique des parcelles de multiplication. Peut être serait-il encourageant dans une première phase de subventionner le prix de tous les herbicides sur céréales, d'autant plus que les pouvoirs publics ont exprimé leur volonté de porter la superficie ensemencée de blé tendre à un million d'hectares et qu'une Association de Producteurs de céréales vient d'être créée, ce qui signifie que le Maroc est déterminé a atteindre l'autosuffisance en blé dans un proche avenir.

Etude d'interactions herbicides techniques culturales:

Etant donné que l'emploi des herbicides entraine avec lui des modifications dans la pratique agricole, il est souhaitable que des travaux soient consacrés a l'étude d'interactions herbicides techniques culturales. A cause de la superficie importante occupée par les céréales, ces interactions seraient étudiées dans le cas des blés. Plusieurs thèmes pourraient être proposés:

- Herbicides x Travail du sol
- Herbicides x Densité de semis
- Herbicides x Fertilisation azotée et phosphorique
- Herbicides x Rotation culturale de blé
- Herbicides x Humidité du sol
- Herbicides x Variétés de blé tendre et de blé dur.

Le dernier thème a fait l'objet d'essais menés dans le cadre d'un sous-projet de coopération avec la GTZ et ayant porté sur l'etude de la sensibilité de quelques principales variétés de blé tendre et de blé dur vis-à-vis d'un certain nombre d'herbicides. La poursuite de ces essais et la réalisation des thèmes suggérés pourraient être confiés a l'Institut National de la Recherche Agronomique.

Lutte integree et vulgarisation:

La voie chimique ne doit pas être perçue comme l'unique solution pour lutter contre les mauvaises herbes. D'autres méthodes de désherbage et des techniques culturales appropriées peuvent s'avérer efficaces et à ce titre compléter ou même se substituer à l'emploi des herbicides. Le probleme du desherbage est une question de contexte, à etudier en fonction des exigences momentanées et des conditions propres à chaque exploitation.

Il est nécéssaire à cet égard de mettre en place des essais démonstratifs comparant les différentes méthodes de désherbage entre elles, de même que leurs combinaisons pour conseiller l'agriculteur.

Selon une enquête sur le désherbage des betteraves sucrières (Link & Mouch, 1983) le désherbage mécanique reste indispensable, encore dans le cas du désherbage chimique, pour éliminer les adventices resistantes. Dans les jeunes plantations de canne à sucre sur sables, des façons mécaniques répétées peuvent venir à bout des principales mauvaises herbes de cette culture; dans une terre lourde, une application d'herbicides complétée par une succession de binages serait nécessaire. Le choix entre traitements généralisés ou localisés mérite également d'être discuté dans certaines cultures et plantations. Et l'on pourrait multiplier les exemples dans ce sens.

Formation:

a - Formation au niveau national

aa - Renforcement de la coopération entre les différents organismes par:
- la publication des travaux et leur encouragement
- la formation de groupes de travail entre divers organismes.
- l'information sur les programmes.

L'AMM constitue le cadre d'échanges et de stimulation le plus approprié et ses contacts avec l'EWRS et l'IWSS contribueraient sans aucun doute au développement de la Malherbologie.

ab- Développement de la vulgarisation de la lutte chimique et intégrée par les I.R.P.V. par:
- des stages d'information pour les agents des Inspections Régionales de la Protection des Végétaux.
- la préparation de fiches ou dossiers techniques de désherbage et d'un index d'herbicides homologués par culture...
- la publication d'une revue de la Protection des Cultures.

ac- Documentation:
- moderniser la bibliothèque de l'Institut National de la Recherche Agronomique et créer une autre à la Direction de la Protection des Végétaux des Contrôles Techniques et de la Repression des Fraudes pour la Protection des Plantes et s'abonner aux revues internationales: Weed Abstracts, Weed Research, Weed Science, comptes-rendus des congrés et colloques internationaux sur la malherbologie ... et doter ces bibliothèques d'appareils photocopieurs.
- organiser des seminaires et cours sur la malherbologie
- préparer une brochure illustrée pour l'identification et la reconnaissance des principales adventices.

- tenir un herbier d'adventices à l'I.N.R.A. et créer une cellule pour la détermination rapide des échantillons de mauvaises herbes.

ad- Développer et introduire des sous-projets de malherbologie à l'intérieur de projets de coopération internationaux.

b- Formation à l'étranger:

- de longue durée dans le cadre d'une thèse:
  les thèmes proposés concernent les adventices vivaces ou difficiles à détruire: Convolvulus arvensis, Oxalis cernua, Thesium humile, Solanum elaeagnifolium, l'expérimentation herbicide des céréales et l'étude des seuils de nuisibilité des mauvaises herbes dans ces mêmes cultures ...
- de durée moyenne pour thèse dans le pays:
  Les études pourraient porter sur l'évolution de la flore adventice en relation avec l'emploi des herbicides, l'efficacité des desherbants chimiques dans certaines cultures en milieu méditerranéen ...
- de courte durée:

  De quelques semaines à quelques mois pour les techniciens, afin de leur permettre d'associer théorie et pratique

- de quelques jours:

  Cycles de recyclage; congrés internationaux (IWSS, EWRS ...) et nationaux des associations nationales de malherbologie; échanges de visites entre payes méditerranéens.

Tableau 1. Repartition generale des Terres en 1984

Designation	Superficie en ha	%
Surface totale du pays	69.000.000	100
Surface non agricole	32.000.000	46,4
Surface agricole	28.928.000	42
Forêts	5.106.000	7,4
Steppe (Alfa)	2.622.000	3,8

Source: M.A.R.A.

Tableau 2. Terres utilisees par l'agriculture en 1984

Désignation	Superficie en ha	%
Surface agricole	28.928.000	100
Parcours	20.907.000	72,2
Surface agricole utile	8.021.000	27,8
Terres labourables	7.502.000	
Cultures permanentes	519.000	

Source: M.A.R.A.

Tableau 3. Utilization de la SAU en 1984

Cultures	Superficie x 1000 ha	Rendement qx/ha	Production x 1000 qx
Céréales	4477,6	8,4	37.498,7
Blé dur	1122,5	10,4	11.712,8
Blé tendre	733,3	11,2	8.182,0
Orge	2.126,0	6,6	14.046,3
Mais	383,6	6,9	2.639,6
Autres	112,2	-	918,0
Légumineuses	443,5	5,5	2.455,5
Fèves	190,3	6,4	1.222,9
Petits-pois	57,2	4,8	275,8
Lentilles	67,5	3,6	245,3
Pois-chiches	60,2	4,8	286,6
Autres	68,3	-	424,9
Cultures industrielles	93,0		
Betterave à sucre	53,1	475,6	25.254,39
Canne à sucre	11,3	685,9	7.750,26
Coton	9,6	12,0	115,4
Autres	11,8	-	-
Cultures oléagineuses	54,3	10,0	544,3
Tournesol	29,3	6,5	190,4
Arachide	25,0	14,2	353,9
Cultures fourragères	99,2	-	-
Cultures diverses	187,3	-	-
Cultures maraichères	145,4	147,1	21.383,5
Tomate	16,5	360,8	5.063,1
Pomme de terre	38,7	159,5	6.171,0
Oignon	20,9	107,3	2.242,1
Autres	69,3	114,1	7.909,4
Jachère	2334,4	-	-
Plantations	518,8	-	19.353,5
Olivier	286,6	-	3.267,0
Amandier	31,6	-	491,3
Agrumes	69,3	-	10.170,5
Vigne	56,8	-	2.298,9
Palmier-dattier	21,7	-	254,2
Autres	52,8	-	2.871,6
TOTAL	8021,3		

Source: M.A.R.A.

Tableau 4. Typologie des exploitations

Taille des exploitations en ha	Nombre	%
S < 2	450.290	23,4
2 ⩽ S < 5	1.089.510	56,5
5 ⩽ S < 10	219.860	11,4
10 ⩽ S < 20	114.150	5,9
20 ⩽ S < 50	43.930	2,3
50 ⩽ S < 100	7.750	0,4
S ⩾ 100	2.350	0,1
TOTAL	1.928.020	100

S = Superficie

Annexe I. Principales adventices des cereales et legumineuses

	Céréales (blé dur, tendre, orge)	Légumineuses (fève, pois, lentilles, pois-chiche)
Apiaceae		
Ammi majus		X
Bifora testiculata	X	
Buplerum lancifolium	X	X
Ridolfia segetum	X	
Scandix pecten-veneris	X	
Torilis nodosa	X	
Araceae		
Arisarum vulgare	X	
Boraginaceae		
Anchusa azurea	X	
Brassicaceae		
Capsella bursa-pastoris		X
Raphanus raphanistrum		X
Sinapis arvensis	X	X
Caryophyllaceae		
Silene spp.	X	
Spergula arvensis	X	
Vaccaria pyramidate	X	
Chenopodiaceae		
Chenopodium album		X
Compositae		
Anacyclus radiatús		X
Calendula arvensis	X	
Centaurea spp.		X
Chrysanthemum coronarium	X	
Cichorium intybus	X	
Rhagadiolus stellatus	X	
Convolvulaceae		
Convolvulus arvensis	X	X
Euphorbiaceae		
Euphorbia helioscopia		X
Fabaceae		
Astragalus haetieus	X	
Lathyrus spp.	X	
Medicago hispida	X	X

Annexe I. Principales adventices des cereales et legumineuses (suite)

	Céréales (blé dur, tendre, orge)	Légumineuses (fève pois, lentilles, pois-chiche)
Vicia spp.	X	X
Fumariaceae		
Fumaria officianalis		X
Liliaceae		
Muscari comosum	X	X
Orobanchaceae		
Orobanche crenata		X
Papaveraceae		
Papaver hybridum	X	X
Papaver rhoeas	X	X
Plantaginaceae		
Plantago psyllium		X
Poaceae		
Avena sterilis	X	X
Bromus spp. (*maximus*)	X	
Cynodon dactylon		X
Lolium spp. (*rigidum*)	X	X
Phalaris brachystachys	X	
Polygonaceae		
Emex spinosa		X
Polygonum aviculare		X
Rumex pulcher (*crispus*)		X
Primulaceae		
Anagallis faemina	X	X
Ranunculaceae		
Ranunculus spp.		X
Rubiceae		
Galium tricorne	X	
Scrofulariaceae		
Antirrhinum orontium	X	X

ANNEXE II

LISTE DE TRAVAUX SUR LES ADVENTICES AU MAROC

En français

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En allemand

Hoesle, U. (1981) Untersuchungen zur Unkrautkonkurrenz im Marokkanischen Weizenbau Unter Besonderer. Berucksichtigung des Wasserfaktors. Dissertation, Universität Hohenheim/ Stuttgart.

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WEED MANAGEMENT: COUNTRY STATUS PAPER - PAKISTAN

Rashid A. Shad
National Agricultural Research Centre
P O NIH, Park Road,
Islamabad, Pakistan

BACKGROUND INFORMATION ON AGRICULTURE

Pakistan, basically an agricultural country is located between 24° and 36.75° north and between 61° and 75.5° east. It lies on the margin of one of the major climatic regions of the earth, the monsoon region. In Pakistan, the seasons may be distinguished as follows: cold weather season (mid-December to March); hot weather season (April to June); monsoon season (July to September); and post-monsoon (October to mid-December).

The country covers an area of 79.61 million hectares, of this 20.43 million hectares are cultivated and 76.97% of this area is irrigated and the rest is rainfed (Tables 1 and 2).

The latest count puts the total population at 95 millions; of this 71.71% is rural and the rest i.e. urban (Table 3). Records, since the beginning of the regular census, indicate a general acceleration in the growth of the urban population as a result of economic forces encouraging a migration from the rural areas. The total labour force involved in agriculture is about 10.428 millions or approximately 60% of the working population (Table 3).

In general, the size of holding is small i.e. 51% of the farms are of the size of 0.5 to 3.0 hectares, whereas the number of farms exceeding 60 hectares is negligible (Table 4).

The farming year of Pakistan has two main cropping seasons; Rabi and Kharif. Rabi crops are sown after the rainy season in October and November and harvested in April and May. These include wheat, barley, gram and oil seeds. These crops require lower temperatures and lower rainfall than Kharif crops which are sown between April and June and harvested in October and November. Kharif crops include rice, maize, millets, cotton and sugar cane. However, vegetables are grown in both seasons. Principal vegetable crops of the Rabi season are radish, carrot, turnips, cabbage and cauliflower and of the Kharif season are okra, cucumber, onion, garlic, bittergourd, white gourd, pumpkin, spinach, melons, sweet potato, brinjal and chillies. Two crops of potatoes are raised one in the Rabi season and the second in the spring. Tomatoes are also grown in the Kharif season. The area under these crops is given in Tables 5 and 6. Of these crops, rice, sugarcane, cotton

and vegetables are the crops of irrigated areas and cannot be grown under rainfed conditions. Whereas wheat, barley, gram, maize, millet and oil seeds can be grown in irrigated as well as rainfed conditions. These crops are the principal crops of the rainfed regions, although they are also successfully grown in the rainfed areas.

Orchards are established mainly in the irrigated or high rainfall areas of the north. The main fruits are citrus, mango, guava, apples, peaches, grapes and banana.

THE WEED PROBLEM

All agricultural crops in Pakistan, both irrigated and rainfed, are heavily infested with weeds. The magnitude of the problem can be imagined from the fact that eight of the ten world's worst weeds are found in Pakistan. These are Cyperus rotundus, Cynodon dactylon, Echinochloa crus-galli, E.colonum, Eleusine indica, Sorghum halepense, Panicum maximum, and Eichhornia crassipes (Table 7). Beside these, other problem weeds such as Desmostachya bipinnata, are also present. The density of weeds is so high that sometimes farmers have to plough up the crop before maturity.

The problem is getting worse in field crops because of increasing cropping intensities, especially in the irrigated areas. Fixed crop rotations such as rice/wheat, and cotton/wheat in the rice and cotton belts, respectively encourage the establishment of permanent weed flora. The cropping intensity is still higher in vegetable farming. In such farming systems very little time is left for weed management through land preparation practices or crop rotations. The only choice is to depend on post-planting operations. Because of the lack of a well-defined, effective and economical weed management technology package, farmers are bound to follow traditional methods which are not only less efficient but are also labour intensive. Due to the high costs of labour and labour shortages, caused by the shift to urban areas and to oil producing countries, complete weed control coverage is usually not possible. Only partial weed control is practised and that in the food/cash crops only. Because of the labour problems weed control operations are often not done at the optimum time. Some of the farmers also let the weeds grow to the maximum to be used as fodder. The situation is still more alarming in the rainfed areas where the crop yields are very poor and the farmers cannot afford to invest in weed management. This situation leads to a build up of weed propagules, making the existing weed management practices still less effective.

At the government level, weed management has never been considered to have the same priority as the other pest management disciplines. So far very few training facilities have been available in weed management and the country is very short of trained manpower. Now, government has realised the severity of the problem and a coordinated Weed Research Program has been set up at the National Agricultural Research Centre (NARC) under the auspices of the Pakistan Agricultural Research Council (PARC). The National Research Program on Weed Control has been approved in the 6th five-year plan.

ASSESSMENT OF CROP LOSSES DUE TO WEEDS

Agricultural experts have experimentally assessed the losses in yields in wheat, rice, maize cotton, sugarcane and pulses (Table 8). For the other crops such as vegetables, orchards and oil seed crops work still needs to be done. The losses are usually higher in rainfed areas than in irrigated areas because of the poor crop growth and low moisture status of the soil under which weeds can survive better than the crop plants.

Farmers estimates of yield losses far exceed those assessed by the experts. According to farmers crop losses could be as high as 15-100%. There are instances when the farmers plough up their immature crops because of severe weed problems.

CULTURAL PRACTICES ON SMALL SCALE FARMS AND ON LARGE AND STATE FARMS

Land preparation operations are aimed at destroying weeds and attaining a favourable soil environment for easy planting and growth of the crops. These operations in Pakistan can be divided into two categories; preparatory tillage and seed bed preparation. Preparatory tillage operations, which are started immediately after the harvest of the preceding crop, include ploughings followed by plankings. First ploughing is done at a stage when the field is at an optimum moisture condition to avoid any clodding, easy operation of the implement and to attain proper soil texture conditions. Proper moisture conditions are sometimes obtained by irrigation if the residual soil moisture is not enough. In rainfed areas, farmers have to wait for the rain to start tillage operations. Subsequent ploughings and plankings are done in the dry soil at intervals, the length of interval being dependant on the interval between the preceding and the succeeding crops. Frequency of preparatory tillage also depends on the interval between preceding and the following crop and the work load of the farmers.

Seed bed preparatory tillage operations start about 10-15 days before planting. The field is again irrigated and all the ploughing and planking operations are done at an optimum soil moisture. The average number of ploughings and plankings followed by a leading farmer are given in Table 9. Tillage operations at the state farms and on the large farms are done mostly by means of tractors whereas small scale farmers use bullocks for this purpose. The tendency to hire tractors for land preparation is developing.

Rainfall in Pakistan is deficient because the country lies on the arid margin of the sub-continent's monsoon region. However the Indus river and its tributaries provides excellent opportunities for irrigation. Pakistan has a splendid system of surface and sub-surface irrigation in the form of barrages, wiers, canals, wells and tubewells serving a vast area. The existing system of irrigation although very impressive, is still inadequate for present needs of the increased cropping intensities. Canal water supplies are being supplemented with tubewells where subsoil water is fit for irrigation. Even in the rainfed areas where subsoil water is not very deep and is fit for irrigation tubewells have been installed and the tendency is increasing day by day.

The irrigated area is served by more than 40 major canal commands. Main canals start from a barrage, a dam or weir on a river. A barrage feeds one or more main or link canals. A number of minor distributaries feed out of the main canal and these, in turn serve a number of outlets to the farmers water courses, each of which irrigates between 150 and 600 acres.

Pakistani soils are very responsive to the application of nitrogenous and phosphatic fertilizers and most of the farmers use these fertilizers. Potassium and micronutrients are used by only a few leading farmers and at government farms. Phosphatic fertilizers are usually applied before the last tillage operation whereas nitrogenous fertilizers are used in split doses, one instalment being used as basal. A list of the types of fertilizers available in Pakistan is given in Table 10.

Crops in Pakistan are commonly harvested by manual labour with the help of sickles. Mechanical harvesting which is a new introduction is also progressing well. At present only a few big farmers own reapers and harvesters for harvesting wheat and rice. A trend is developing among small scale farmers to hire reapers for harvesting these two crops. Wheat is mostly threshed by machine although most of the farmers do not own a thresher and have to pay to get their crops threshed. Fruits, vegetables and other field crops are harvested by hand labour.

IMPORTANT WEEDS

Lists of weeds present in various crops are given in Tables 11 and 12. These lists include some of the most difficult to control weeds. Besides these parasitic weeds such as orobanche in tobacco are sometimes found. Most important weeds of rice are Echinochloa crus-galli, Fimbristylis littoralis, Cyperus difformis and Cyperus rotundus. Whereas most important weeds of wheat in rice-wheat cropping system are Phalaris minor and Avena fatua. In rainfed areas, besides these weeds Carthamus oxycantha and Convolvulus arvensis are also very common. Chenopodium album is a weed present in wheat in irrigated as well as rainfed areas.

In irrigated maize, Trianthema monogyna, Cyperus rotundus and Portulaca spp. are the important weeds but in rainfed areas problem weeds are Sorghum halepense, Cyperus rotundus, Portulaca spp. and Tribulus spp.

Trianthema monogyna is emerging as the most important weed in cotton beside Tribulus spp. In sugarcane, Sorghum halepense, Tribulus spp., Trianthema monogyna, Cyperus rotundus and Cynodon dactylon are the important weeds.

Orchards of Pakistan are commonly infested with weeds such as Cyperus rotundus, Cynodon dactylon, Sorghum halepense with others appearing in the summer (kharif) and winter (rabi) seasons.

Vegetables are usually cultivated under irrigated conditions in fertile soils. The fields are heavily fertilized with organic and inorganic manures. These conditions provide a good environment for weed growth. As a result vegetables are infested with almost every weed of the season. Hand weeding is the common method of weed control and requires a lot of labour. Many aquatic weeds have also been identified in Pakistani waters and a list of them is given in Table 13.

NEW WEED PROBLEM

At present Trianthema monogyna in cotton and maize and Phalaris minor in wheat are emerging as problem weeds. Phalaris spp. is a new introduction with the imported seeds, whereas Trianthema monogyna was already in the country and has become a serious weed because of the changing environment and its high seed production capabilities. Broussonetia papyrifera, which was introduced as an ornamental, is spreading very rapidly and could cause serious problems in orchards and forests. Similarly Xanthium spp. is also emerging as a problem weed in maize especially in the high rainfall

areas. It was observed last year that Anagallis sp. could become a problem in wheat where weed management involves herbicides because none of the available herbicides controls it. Eichhornia crassipes, an aquatic weed has been found in ponds and water logged areas (waste). If its spread is not checked, it could cause a great problem in the canals and water reservoirs of the country.

LEGISLATION FOR WEED CONTROL

At present no legislation for weed control exists in the country.

WEED MANAGEMENT

Traditionally, weeds in field crops are managed through cultural practices and hand weeding. Land preparation is done to control weeds, and is supplemented by post-planting weeding by hand or machine depending upon the crop and crop establishment methods. For example, before planting rice, intensive ploughing and planking (puddling) operations are done at intervals in standing water. Intervals are arranged to allow the weed seeds to germinate and then be killed by the subsequent tillage operations. In post-planting operations, weeds are usually pulled by hand but some mechanical devices are used which damage the crop plants as well as the weeds. In wheat, land is ploughed and planked again and again under optimum moisture conditions. Then it is left undisturbed for a week or so to allow the weed seeds to germinate. Subsequent ploughing kills all the germinated weeds. The practice is called "DAB". Hand weeding operations in this crop include hand hoeing with the help of a local sickle or khurpa (a small spade). An implement called a barharrow is also used for weed control in wheat. This implement has small sharp tines and is drawn by bullocks. A pre-plant practice similar to that used in wheat is followed in maize, cotton and sugarcane. Post-planting operations include either hand hoeing with the "Khurpa" or ploughing with bullocks. This ploughing operation called "sealing" in some areas, and usually causes lot of damage including uprooting some of the crop plants. In case of vegetables, hand hoeing with the "Khurpa" is the only method used. It is repeated several times depending upon the kind of vegetables being grown.

Herbicide use in Pakistan is not very common. Only a few big farmers use them for sugarcane, rice and wheat crops. On government farms the practices used by farmers are followed. The only difference is that on the government farms the crops are usually sown in lines and the operations with bullock or tractor drawn implements are not so damaging. Also improved implements are used

instead of the traditional ones. Herbicide use is still not common on the government farms.

EXTENSION

For the purpose of disseminating agricultural technology, each province in the country has an independent agricultural extension department headed by a Director General. The Pakistan Agricultural Research Council has also established a unit for the transfer of technology. In addition programmes are arranged by Radio Pakistan. The information wing of agricultural research also publishes information in the form of brochures for distribution. In spite of all this the extension services have not proved to be very effective particularly on the dissemination of information on weed management. This could be due to the fact that losses caused by weeds were underestimated, both by the extension workers and the farmers. Presently, an approach to teach the farmers through on-farm research/ demonstration trials conducted by the weed science division of NARC is proving effective.

TRAINING

Training on weed management has been very meager in the past. This is because of a lack of trained instructors in the country; an underestimation of weed problems and the nonexistance of an independant discipline. Even at the college/university level, teaching of weed science is almost negligible. However, three short courses/workshops on weed management have been arranged by PARC with the cooperation of the International Plant Protection Centre, Oregon State University, USA. The participants were working scientists from various institutions of the country. As a result the country now has semi-trained personnel available in almost every institution. Recently some scientists have been sent abroad by PARC for degree programmes specialising in weed science.

ACCESS OF FARMERS TO WEED CONTROL PRODUCTS

Farmers have almost no experience in herbicide use, although they wish to have an effective and economical weed control technology package which would include herbicides. Herbicide screening trials have been in progress by the crop specialists/crop protection specialists for the last 10-15 years but the technology has not been accepted so far by the common farmer. One of the reasons for this could be that the herbicides and application equipment are not within easy reach of the farmers. There are very few registered herbicides (Table 14) and these are not easily available in the

market. Also the prices of the herbicides and equipment are high and farmers are not yet fully convinced of their usefulness. As a result, herbicide use is negligible in the country. However the situation seems to be improving and some herbicides recommended for use in rice, wheat, maize and sugarcane have started appearing on the market but are still not within the reach of a common farmer. The use of sprayers still seems to be unlikely, suggesting that research is needed on techniques to apply herbicides without the involvement of sprayers.

RESEARCH IN WEED CONTROL

In Pakistan, the recognition of weed science as a discipline at par with other crop protection disciplines such as entomology and plant pathology, is still very much at the infant stage. There are very few researchers on weed science in the country and those there are, not weed science specialists. The responsibilities of weed research have been given to crop specialists and crop protection specialists who have very little or no training at all in weed management. As a result no systematic research work has been carried out by the researchers and their activities have been concentrated mainly on herbicide screening.

At present there is a single national weed research project "Weeds of Cereals" in progress in the country. The project is nationally coordinated, supervised by the National Coordinator (Weed Science) of PARC. Its units are located in all the four provinces of Pakistan and conduct their research on weeds of cereals only. The project includes staff facilities, laboratory equipment and a vehicle. This is the 2nd year of the project and it is progressing very well. The crop specialists of various crops are also doing some research on weeds but have not got enough laboratory facilities. The laboratories are not well equipped for research on the modern lines. Even simple equipment, such as leaf area meters, ovens and incubators are not available. The same is the situation with chemicals required for research and also travelling facilities are very poor.

Weed research has not progressed well in the country because of the following problems:

1. Late realization by the policy makers of the magnitude of weed problem.
2. Lack of trained manpower. At present except for one Ph.D. in weed science, there is not a single trained weed expert in the country. Those engaged in weed research are botanists, plant physiologists, crop specialists and entomologists.
3. Literature on weed science is not available. At present not

a single international journal on weed research is received in the country. Books on weed science are also not available. Information on international weed research is badly needed for the orientation of local researchers.

4. Chemicals/herbicides are not available for lab and field research. Very few herbicides are available for testing. Some of the herbicides doing very well in other countries are not available in Pakistan.

5. Shortage of funds is the main constraint in weed science research. The subject still being at an infant stage in the country it is not placed among the top priorities as far as allocation of funds is concerned. Universities need funds for specialisation of their students, as well as research institutes for research.

6. Enough funds are not available for the researchers to attend international workshops/conferences on weed science to aquaint themselves with the latest research developments.

In spite of all the constraints the researchers have made some progress in the field of weed management. Weed flora of the important crops have already been identified. Available herbicides for various field crops particularly rice, wheat, maize, sugarcane and cotton have been screened and recommendations can be made for their use in various crops. In addition the Weed Science Program of NARC although only one year old, has made good progress in research. Surveys have been conducted to arrive at the real weed problems in the farmers fields. Critical periods of weed-crop competition in rice, wheat and maize have been determined. The optimum and most economical doses of various herbicides and their methods of application have been evaluated. Research on the cultural, biological and allelopathic methods of weed control is in progress. This unit has had interesting results with allelopathy which may be used as a tool to control very serious weeds of field crops. Some research on aquatic weeds has also been in progress in the past and researchers of the project have identified the aquatic weed flora in Pakistan. Some findings on the control of water hyacinth have also been made.

LITERATURE ON WEED MANAGEMENT

As mentioned earlier, due to the serious shortage of trained weed specialists, not much has been published in the country. Only brochures on weed management have been written by various crop specialists emphasizing the weed problem and suggesting some methods of weed management. So far no scientific book has been published. From time to time research papers on the performance of herbicides based on field experiments are being published in local journals. Annual/final reports on the projects relating to weeds are available. Some of them are:

i. Biology of weeds
ii. Control of aquatic weeds
iii. Pest management program
iv. Weeds of cereals

CONCLUSIONS AND SUGGESTIONS FOR IMPROVED WEED MANAGEMENT

General conclusions

Pakistan is basically an agricultural country with about 71% of the population directly dependent on agriculture and 3/5 of the working force engaged in this profession. Besides providing food and employment, a major part of foreign exchange is also earned through the export of agricultural commodities. The Government of Pakistan is fully conscious of the importance of agriculture and is doing every thing possible for its improvement.

Weed management

1. All crops are infested with different types of weeds, perennials as well as annuals. Losses in yield could vary from 15 to 100% depending upon the density and type of weed present.
2. In the past losses caused by weeds were underestimated by the farmers and the government, but at present all concerned agencies are fully conscious of the magnitude of weed problems.
3. Important weeds are Cyperus spp., Sorghum halepense, Cynodon dactylon, and Desmostachya bipinnata.
4. Important weeds of rabi crops are Phalaris minor, Avena fatua, Carthamus oxycantha and Anagallis spp. and important weeds of kharif crops are, Trianthema monogyna, Tribulus spp., Echinochloa spp., Fimbristylis littoralis and Portulaca spp.
5. Important weed problems are Phalaris minor in wheat, Trianthema monogyna in cotton and maize, Echinochloa spp. and Fimbristylis littoralis in rice, and weeds such as Cyperus spp., Cynodon dactylon, Sorghum halepense and Desmostachya bipinnata in sugarcane and orchards.

6. Spread of Xanthium spp., Eichhornia crassipes and Broussonetia papyrifera needs to be checked.
7. Legislation for weed control does not exist in the country. Agricultural sector lacks a well defined weed management technology package for any crop. Farmers are following traditional methods of weed management which include, intensive preplanting land preparation and post-planting hand/mechanical weeding. Herbicide use is almost negligible. One of the reasons is that weed control products are out of the reach of the farmers and involve high investments.
8. Due to high labour costs and labour shortages in the country complete coverage by post-planting weed control operations is not possible.

9. There is serious shortage of manpower trained in weed science. Training facilities and frequencies are almost negligible. National and international literature on weed management is not available to the scientists/farmers.

10. Research activities on weed management are not well planned. There are very few researchers in the country and they are not trained weed scientists. Except for NARC, none of the institutions in the country involved in agricultural research has an independent discipline responsible for research on weed management.

Suggestions

1. Strengthening of Weed Research Program:

Existing research activities on weed management are not satisfactory and need strengthening. The existing nationally coordinated weed research programme of PARC should be strengthened and expanded to all the institutes engaged in agricultural research.

2. Planning of Research Work:

The present research is not well planned and there is no coordination except within the PARC coordinated weed research programme. There is a need for a weed science expert to help in the planning of a national programme of weed research with the cooperation of local scientists.

3. Training:

The country is very short of manpower trained in weed science. Farmers, extension workers and even the researchers are ill informed in weed management. To overcome this short term and long term training leading to degree programmes should be undertaken. Students, researchers and extension workers should also be provided with training in foreign countries where expertise in weed management is available.

4. Extension:

After refinements, available weed management technology can be utilized to reduce the yield losses caused by weeds. To achieve this goal extension services should be improved and made more effective. This may include the extensive demonstration of weed management technology through on-farm trials, audiovisual aids, farmers gatherings and distribution of published materials. Radio, television and news media should also be exploited for this purpose.

5. Literature:

At present the country is very short of literature on weed management. Arrangements should be made so that libraries of all agricultural institutes should receive copies of at least leading journals on weed science. Books on weed science should also be made available. There is a lot of available information on weed science which has not so far been published. All information should be compiled and published. Researchers should be encouraged to write

research papers, popular articles and brochures on weed management aspects of crop production. Introduction of a regular journal "Pakistan Journal of Weed Science" will be helpful in this regard. Similarly at the regional level a journal "Weed Science Journal of the East" should also be launched. Exchange of literature between the regional countries should be arranged.

6. Seminars/Workshops/Conferences:

National and regional seminars/workshops should be arranged, and planners, scientists and research managers should be invited to participate. This will play a great role in the orientation of all concerned with weed management problems. Working national/regional scientists should be provided opportunities to attend such meetings held in other countries.

7. Weed Science Societies:

Little coordination exists between national as well as regional weed management activities. Establishment of national and regional weed science societies will go a long way towards the improvement of coordination of weed management activities in the region. Annual meetings of the regional society should be held alternatively in the member countries.

8. Collaborative Research Projects:

National research activities of the countries of the region should be interlinked, which in turn should have collaboration with institutes of repute (may be out of region) specialised in weed management. Exchange of visits of scientists should be enhanced.

9. Study of Weed Management Problems of the Region:

A group of the regional weed scientists with at least one expert from each member country should be arranged to study the weed management problems of the region keeping in view the existing resources. On the basis of the report of this group, programmes for improved weed management should be drawn up.

10. Regional/International Research Institute on Weed Management:

In order to concentrate on the regional weed management problems, setting up of a regional/international research institute in any country of the near-east is proposed.

Table 1. Land Use Statistics of Pakistan During 1982-83

Area (Million hectare)

Provinces	Geographical area	Total area	Forest area	Not available for cultivation	Culturable waste	Cultivated area	Current fallow	Net area sown	Area sown more than once	Total cropped area
Pakistan	79.61	56.70	2.99	22.37	10.91	20.43	4.73	15.70	4.40	20.10
Punjab	20.63	16.99	0.44	2.87	2.10	11.58	1.11	10.47	3.09	13.56
Sind	14.09	12.54	0.66	4.35	2.08	4.45	2.38	3.07	0.44	4.01
NWFP	10.17	8.09	0.82	0.99	1.35	1.93	0.43	1.50	0.35	1.85
Baluchistan	34.72	19.08	1.07	11.16	5.38	1.47	0.81	0.66	0.02	0.68

Source: MINFA Agri. Statistics of Pakistan 1983 pp. 112

Table 2. Province-wise irrigated and rainfed area in Pakistan, 1982-83 (million hectares)

Province	Irrigated		Rainfed		Total
	Area	Percent	Area	Percent	
Pakistan	15.47	76.97	4.63	23.03	20.10
Punjab	11.03	81.34	2.53	18.66	13.56
Sind	3.07	76.56	0.94	23.44	4.01
NWFP	0.78	42.16	1.07	57.84	1.85
Baluchistan	0.59	86.76	0.09	13.24	0.68

Source: MINFA Agri. Statistics of Pakistan, 1983, p. 115

Table 3. Population, March 1985

(Million persons)

Pakistan	Population	Percent
Urban	26.882	28.29
Rural	68.118	71.71
Total	95.000	100.00

Estimated Labour Force (Agriculture) 1982-83 is 10.428 million.

Source: Pakistan Economics Survey, 1985.

Table 4. Number and area of Private Farms classified by size, 1980

Size of farm (in hectares)	Farm	
	Number	Percent
Under 0.5 to 3.0	2.07	51
3.0 to under 5.0	0.92	23
5.0 to under 10.0	0.71	17
10.0 to under 20.0	0.26	6
20.0 to under 60.0	0.10	3
60.0 and above	0.01	*
Total farms	4.07	100

* = Negligible

Source = Census of Agriculture, 1980

Table 5. Area under Rabi and Kharif Crops in Pakistan During 1982-83 (1000 hectares)

Crop	Area	Percent
Cereal crops	11256.7	56.00
Vegetables*	195.8	0.97
Orchards	368.7	1.84
Oil seeds	499.6	2.84
Pulses	1335.4	6.63
Sugar cane + Cotton	3174.6	15.78
Fodders	3270.0	16.30

Source: MINFA, Agri. Statistics of Pakistan, 1983

* = Vegetables including Potato

Table 6. Current cropping pattern in Pakistan
(per cent)

Year	Crops					
	Wheat	Rice	Maize	Cotton	Sugarcane	All other crops
1977-78	34.4	10.3	3.5	10.0	4.5	37.3
1978-79	34.6	10.5	3.4	9.8	3.9	37.8
1979-80	36.0	10.0	3.6	10.8	3.7	35.3
1980-81	36.1	10.0	4.0	10.9	4.3	34.7
1981-82	36.5	10.0	3.7	11.2	4.8	33.8
1982-83	36.8	9.8	3.9	11.3	4.5	33.7

Source: MINFA, Agricultural Statistics of Pakistan, 1983

Table 7. The worst weeds of the world (Holm 1969)

1. Cyperus rotundus*
2. Cynodon dactylon*
3. Echinochloa crus-galli*
4. Echinochloa colonum*
5. Eleusine indica*
6. Sorghum halepense*
7. Panicum maximum*
8. Eichhornia crassipes*
9. Imperata cylindrica
10. Lantana camara

*Weeds present in Pakistan

Table 8. Assessment of crop yield losses due to weeds

Crop	Yield losses (%)
Wheat	17-25
Rice	20-63
Maize	20-45
Cotton	13-41
Sugarcane	10-35
Pulses	25-55
Oil seeds	N.A.*
Vegetables	N.A.
Orchard	N.A.
Fodders	N.A.

*Not available

Table 9. Land Preparation Practices for Various Crops in Pakistan
Average Leading Farmer

Type of Land Preparation	Number of Ploughings & Plankings								
	Irrigated Crops								
	Wheat	Rice	Maize	Cotton	Sugarcane	Potato	Onion	S.bean	Sunflower
Preparatory tillage	4	3	4	2	(8)	4	(5)	3	3
Seed bed preparation	2	2	3	2		3		2	2

	Rainfed Crops				
	Wheat	Chickpea	Mongbean	Millets	Sorghum
Preparatory tillage	3	2	2	2	2
Seed bed preparation	2	2	2	1	2

Table 10. Types of fertilizers used in Pakistan

	Nitrogen	Phosphorus	Potash	Micronutrients
1.	Urea (46% N)	Single super phosphate (18% P_2O_5)	Nitrophoska (14% K_2O)	Shadab
2.	Ammonium sulphate (21% N)	Nitrophos (23% P_2O_5)	Potassium sulphate (25% K_2O)	Zar Zamin
3.	Calcium ammonium nitrate (26% N)	Diammonium phosphate (46% P_2O_5)		Zinc sulphate
4.	Nitrophos (23% N)	Nitrophoska (14% P_2O_5)		Zinc oxide

Note: Farm yard manure, compost and green manures are also used

Table 11. Important weeds of cereals

Wheat	Maize	Rice
Asphodelus tenuifolis Cav.	Echinochloa sp.	Cyperus difformis L.
Anagallis arvensis L	Cynodon dactylon	Cyperus iria L.
Avena fatua	Sorghum halepense	Cyperus rotundus
Carthamus oxyacantha Bieb	Cyperus rotundus	Scirpus maritimus (Sind only)
Chenopodium album L.	Rumex sp	Echinochloa colonum L.
Chenopodium murale L.	Digera arvensis	E.crus-galli
Convolvulus arvensis L.	Melilotus sp.	Fimbristylis littoralis L.
Cynodon dactylon Pers.	Trianthema monogyna	Marsilea minuta L.
Cirsium arvense L.	Euphorbia sp.	Nymphaea stellata
Cyperus rotundus L.	Chenopodium album	Sagittaria spp.
Euphorbia helioscopia L.	Chenopodium murale	Paspalum disticum L.
Fumaria indica (Hussk)	Convolvulus arvensis	Sphenoclea zeylanica Gaertn.
Lathyrus aphaca L.	Tribulus terrestris	Cynodon dactylon Pers.
Lapidium sativum L.	Amaranthus spinosis	
Malva neglecta L.	Portulaca sp.	
Medicago denticulata Wild.	Sphenoclea sp.	
Melilotus indica L.	Euphorbia pilulifera	
Phalaris minor	Solanum nigrum	
Rumex dentatus L.	Digitaria sanguinalis	
Sorghum halepense L.	Setaria glauca	
Saponaria vaccaria L.	Desmostachya bipinnata	
Sonchus oleraceus L.	Dactyloctenium eagyptium	
Vicia sativa L	Xanthium strumarium	
Festuca crustata L.	Eleusine indica	
	Panicum virgatum	
	Panicum repens	

Table 12. Important weeds of cotton and sugar cane

Cotton	Sugar cane
Echinochloa sp.	Achyranthes aspera, L.
Cynodon dactylon	Amaranthus polygamus L.
Sorghum halepense	Convolvulus arvensis L.
Cyperus rotundus	Corchorus depressus (L.)
Digera arvensis	C.trilocularis L.
Melilotus sp.	Cynodon dactylon (L.)
Trianthema monogyna	Cyperus rotundus L.
Euphorbia sp.	Desmostachya bipinnata (L.)
Chenopodium album	Dichanthium annulatum (Forsski)
Convolvulus arvensis	Digitaria sanguinalis (L.)
Tribulus terrestris	Eclipta alba (L.) Hasskl.
Amaranthus spinosis	Echinochloa colonum (L.)
Portulaca sp.	Eleusine flagillifera Nees
Euphorbia pilulifera	E.indica (L.) Gaertn
Digitaria sanguinalis	Eragrostis poacoides P. Beauve
Desmostachya bipinnata	Euphorbia hirta L.
Dactyloctenium aegyptium	E.pilulifera Var. hirta
Eleusine indica	Lippia nodiflora (L.)
	Phyllanthus niruri (L.)
	Rhinchosia minima
	Trianthema monogyna L.
	Tribulus terrestris L.

Table 13. Aquatic Weeds of Pakistan

Marsilea spp.
Azolla pinnata R.Br.
Salvinia cucullata Roxb.
Typha angustata Bory. & Chaub.
Sparganium ramosum Huds.
Potamogeton spp.
Zannichellia palustris Linn.
Najas spp.
Sagittaria spp.
Butomus umbellatus
Hydrilla verticillata Royle
Vallisneria spiralis Linn.
Pistia stratiotes Linn.
Lemna spp.
Wolffia spp.
Eichhornia crassipes (Mart.) Solms.
Monochoria vaginalis (Linn.) Presl.
Cyperus spp.
Eleocharis spp.
Fimbristylis spp.
Scirpus spp.
Alopecurus nepalensis Trin. ex. Steud.
Alpuda spp.
Coix lacrymajobi Linn.
Crypsis schoenoides (Linn.) Lamk.
Digitaria stricta Roth.ex. Roem & Schult.
Diplachne fusca (Linn.) P. Beauv.
Hemarthria compressa (Linn.)
Hygrorhiza aristata (Retz.) Nees.
Imperata cylindrica (Linn.) P.Beauv.
Ischaemum rugosum Salisb.
Iseilema spp.
Lophochloa phleodes (vill.) Reichb.
Eragrostis spp.
Erianthus ravennae (Linn.) P.Beauv.
Panicum spp.
Paspalidium spp.
Paspalum paspaloides (Mixhx.) Scribner
Phragmites karka (Retz.) Trin.
Pogonatherum crinitum (Thunb.) Kunth.
Polypogon monspeliensis (Linn) Desf.
Saccharum spontaneum Linn.
Setaria spp.
Sporobolus spp.
Vetiveria zizaniodes (Linn.) Nash.
Gonostegia pentandra (Roxb.) Miq.
Polygonum spp.
Rumex chalepensis Mill. Gard.
Alternanthera sessilis (Linn.)Dc.
Nelumbo nelumbo (Linn.) Druce.
Nymphaea spp.
Ceratophyllum demersum Linn.
Ranunculus spp.
Nasturtium officinale R.Br.
Bergia ammonnioides Roth.
Ammannia spp.
Ludwigia perennis Linn.
Trapa bispinosa Roxb.
Myriophyllum spp.
Centella asiatica (Linn.) Urban
Oenanthe javanica (Blume.) D.C.
Nymphoides spp.
Ipomoea aquatica Forsk.
Phyla nodiflora (Linn.) Greene.
Mentha longifolia (Linn.) Huds.
Bramia monnieri (Linn.) Penn. (Bacopa monnieri)
Veronica anagallis-aquatica Linn.
Utricularia spp.

Table 14. List of herbicides registered in Pakistan

Names	Formulations	Holders of Registration certificates	Registration Number	Dated	Validity
Ametryne+Atrazine Gespex Combi	80WP	Ciba-Giegy (Pak.) Ltd.	PAK/APO/86/76	22.6.76	30.6.85
Atrazine+Metolachlor Primextra	500FW	Ciba-Giegy (Pak.) Ltd.	PAK/APO/163/80	7.1.81	30.6.84
Benthiocarb Saturn	6G	Nichimen Corporation	PAK/APO/135/79	21.8.79	30.6.85
Bromoxynil+MCPA Buctril-M	40EC	May & Baker Limited	PAK/APO/161/80	7.1.81	30.6.83
Butachlor Machete Machete	60EC	Chemdyes (Pak.) Ltd.	PAK/APO/126/79	20.8.79	30.6.85
Chlorotuluron+MCPA Dicuran MA	60WP	Ciba-Giegy (Pak.) Ltd.	PAK/APO/147/80	23.1.80	30.6.83
Dicamba Banvel	40.6EC	Velsicol Chemicals Corp.	PAK/APO/97/77	5.5.77	30.6.85
Dimethametryn+Piperophos Avirosan	3.3 G	Ciba-Giegy (Pak.) Ltd.	PAK/APO/77/76	10.3.76	30.6.85
Diuron Karmex	80WP	R.B. Avari & Co	PAK/APO.21.74	14.2.74	30.6.85
Methabenzthiazuran Tribunil	70WP	Chemdyes (Pak.) Ltd.	PAK/APO/72/76	13.2.76	30.6.84
Paraquat Gramoxone	20	I.C.I. (Pak.) Ltd.	PAK/APO/62/75	6.6.75	30.6.84

Table 14. List of herbicides registered in Pakistan (cont)

Names	Formulations	Holders of Registration certificates	Registration Number	Dated	Validity
Pendimathalin Stomp	330E	Cyanamid (Pak.) Ltd	PAK/APO/162/80	29.12.80	30.6.83
Propanil) Stam F-34)	25EC & 36EC	Rhom & Hass Asia Ltd	PAK/APO/95/77	5.5.77	-
Surcopur)	250EC & 360EC	Chemdyes (Pak.) Ltd	PAK/APO/28/74	26.2.74	30.6.86
2,4-D Butylester Esteron	76BE	Dow Chemicals & Pacific Ltd	PAK/APO/204/82	28.8.82	30.6.84
2,4-D Dimethylamine DMA-6	69.6	Dow Chemicals & Pacific Ltd	PAK/APO/204/82	28.8.82	30.6.84
2,4-D Sodium Salt Pol-Pielk	92 WP	Shanimpex Corporation	PAK/APO/102/77	31.8.77	30.6.85
Trifluraline+2,4-D Treflan-R	10 Spreadable 20EC	Elanco International	PAK/APO/146/80	21.1.80	30.6.83

WEED MANAGEMENT: COUNTRY STATUS PAPER - SUDAN

A.M. Hamdoun
Gezira Research Station
Wad Medani, Sudan

BACKGROUND INFORMATION ON AGRICULTURE

The Sudan is the largest country in Africa, with a land area of 237.6 million ha. Of this only 5.2% are under arable crops, 0.25% under permanent crops, 24% under permanent pastures and 20% under forests and woodland. The rest of the land has not so far been developed because it is either dry, swampy or awaiting the availability of funds for development. The irrigated portion is only 1,900,000 ha. Expansion of the cultivated area is continuous in both irrigated and rain-fed areas.

A range of agricultural and horticultural crops are annually planted. Table 1 shows the areas of major crops in 1983.

Estimates of areas under orchards are not available. However, the 1983 production figures for bananas, grape fruits and oranges were 92,000, 59,000 and 51,000t respectively.

The total population of the Sudan in 1983 is about 20.02 million. The agricultural population constitutes 75% of the total population. The economically active population is only 6.158 million and of those 75.1% are engaged in agriculture.

Table 1. Areas of major crops in the Sudan (1983).

Crop	Area in 1000 ha	Remarks
Sorghum	3500	Irrigated and rain-fed
Millet	1100	Rain-fed
Groundnuts	974	Irrigated and rain-fed
Sesame	800	Rain-fed
Cotton	392	Irrigated and rain-fed
Wheat	130	Irrigated
Pulses	78	Irrigated
Maize	65	Irrigated and rain-fed
Sugar cane	50	Irrigated
Cassava	46	Rain-fed
Yams	40	Rain-fed
Vegetables	40	Irrigated
Broad-beans	16	Irrigated
Castor beans	10	Irrigated

The size of holdings is quite variable and is dependent on the locality of the farm, the crop and whether the crop is irrigated or rain-fed. In the irrigated schemes where cotton is produced the size of the holdings range between 6.3-16.5 ha. In the mechanised farms of the central rainlands the holdings range between 420-8400 ha. The size of holdings in the traditional sector in the rainlands and in the irrigated vegetable farms along the Nile is 2.5-7.0 ha.

THE WEED PROBLEM

Importance

Weeds in the Gezira Scheme as well as in other Schemes such as Rahad, New Halfa, El Suki, Blue Nile, White Nile, Northern Region Agricultural Corporation, Gash and Tokar Delta are a serious problem. Such schemes are examples of the rapid conversion of vast desert and semi-desert areas into intensive agricultural production with a resultant shortage of labour for many operations including the control of weeds.

In irrigated agricultural and horticultural crops perennial weeds such as Cynodon dactylon (L.) pers., Cyperus rotundus L., Ischaemum afrum (Gamel.) Dandy and Panicum repens L. are some of the most serious weeds. Surveys carried out in the Gezira scheme show that about 10-17% of the cotton fields and about 20-30% of the

fallow are infested with C.dactylon. This species has become so serious a weed that heavily infested tenancies were abandoned because control measures with the currently used herbicides, the available cultivation equipment and hand weeding operations prove to be inadequate. Furthermore, appreciable areas adjacent to field channels are heavily infested and are not cropped.

The monocropping of sorghum or millet, tomatoes or egg plants and alfalfa following recent intensification of cropping has led to the spread of parasitic weeds such as Striga hermonthica (Del.) Benth, Orobanche ramosa L. and Cuscuta hyalina Heyne ex Roth., which are difficult to control by cultural, chemical or manual methods. Annual weeds such as Brachiaria eruciformis (Smith) Griseb, Setaria spp. and Echinochloa colonum (L.) Link, cause serious reduction in yield because of labour shortages at peak periods of work on large agricultural schemes and also on small vegetable holdings.

In the rain-fed areas approximately 8,000,000 ha are annually planted with sorghum, millet, sesame, root crops, groundnuts and cotton. Mechanized farming has considerably expanded in the last decade. This expansion is taking place at a time when labour demand is high and costs are rising. Serious weed problems are encountered. Many areas have become so heavily infested with annual and perennial weeds that it is expensive and difficult to control them and such areas are often abandoned e.g. some mechanized farms at Samsam and many areas around villages.

In the flush irrigated Gash and Tokar Deltas the main crop husbandry problem is weeds which cannot be controlled by mechanical means or by hand weeding. During the 1975-76 season 12,500 ha were not cropped in the Gash Delta because of excessive weed growth.

Weeds do not only compete with crops but also act as alternate hosts for pests and diseases. A number of weed species e.g. Euphorbia spp. and Hibiscus spp. are alternate hosts of Levillula taurica which infests a wide range of vegetable crops. The smut, the leafspot and rust fungi of sorghum have some weed hosts among the grasses which closely resemble sorghum. Acalypha indica L., Datura stramonium L. and Solanum dubium Fr. were found to be among the best alternate hosts, both as donors as well as receptors of leaf curl, Nicotiana virus 10, which often results in severe outbreaks in tomato in various localities throughout the Sudan.

Insects associated with weeds act as vectors of plant viruses. Over 50 weed species are alternative hosts of the cotton whitefly which is a vector of both cotton and tomato leaf curl viruses and is also associated with the problem of stickiness in cotton. Furthermore, almost all the important cotton pests in the Sudan tend to have one or more alternate weed hosts.

Aquatic weeds are a major problem in the Sudan. About 1600 km of the Nile above Jebel Aulia dam, near Khartoum, are seriously infested with water hyacinth (Eichhornia crassipes (Mart.) Solms). Still further to the south hundreds of kilometers of tributaries are also infested. Aquatic weeds interfere with the passage of steamers and cause excessive damage to machinery. The water hyacinth causes an increase in water loss when compared to a free water surface. The total water loss due to its presence could equal 7,000,000,000 m^3 annually (Dissogi, 1974). This represents one tenth of the average yield of the Nile. Fishing sites become inaccessible, nets and gear become fouled and fish populations are reduced. Water may be polluted by heavy weed infestation and public health is usually endangered because the weed mats harbour insects and snails which are vectors of human and animal diseases. Irrigation pumps are often blocked by weeds. In irrigated areas evaporation and seepage losses are excessive and canals silt up rapidly when flow is retarded by weeds. Yield is reduced in irrigation schemes because water cannot be supplied on schedule when weeds infest the canals.

In the irrigation canals and ditches of the Sudan the presence of several species of submerged and semi-aquatic weeds is causing excessive water loss and has resulted in short supply of water for portions of the irrigated schemes. The most troublesome species in canals are Potomogeton sp., Najas pactinata (Parl.) Magnus, Ottelia alismoides (L.) pers., Vossia cupsidata (Roxb.) Griff., Typha angustata L., Panicum meyrianum Nees., Echinochloa stagnina (Retz.) Beauv., Phragmites mauritianus Kunth and Ipomoea reptans L.

Attitude of farmers and government

In the irrigated state farms the tenants and unions are deeply concerned about the difficult weed situation. Their persistent demands include deep blading, provision of sufficient irrigation water for pre-watering and herbicide application in all crops. Weeding operations are started soon after weeds emerge and 2-4 weedings are made. Scheme managements, however, are biased towards cotton. Deep blading, pre-watering and herbicides are only provided for that crop. Moreover penalties are enforced on tenants that fail to control weeds in cotton. Extension is mainly directed towards cotton cultural practices.

Farmers of the mechanized farms are well aware of their weed problems and have bitterly complained about heavy infestations of Corchorus spp., Sorghum spp., I.afrum and S.hermonthica. In an endeavour to combat weeds they perform 2-3 wide level discing before crops are sown and later on 1-2 hand weedings. Some farmers use herbicides in sorghum and cotton. The government seems indifferent to weed control problems in these areas. Foreign exchange is not

made available for the purchase of herbicides and extension personnel and facilities are meagre.

The vegetable farmers all along the Nile and the traditional farmers in the rainlands are enthusiastic about controlling weeds. Depending on competitiveness of the crop and weed density 2-5 weedings are made. Such small holdings receive little or no government support and extension is almost absent.

As regards the water hyacinth in the Nile the Plant Protection Directorate is responsible for its control. Legislation prohibiting the transport of whole plants or portions of it to uninfested areas is enforced. Occasionally information relating to the hyacinth infestation, its hazards and danger of its transportation from one location to another and the law and penalties pertaining to such actions is disseminated through the press and broadcasting media in order to educate the public. The government spends several million pounds annually on chemical and manual control.

Control of aquatic weeds in the canal system of the irrigated schemes is the responsibility of the Ministry of Irrigation. Huge efforts are made to control severe infestations by mechanical, manual and chemical means and annual expenditure exceeds 4 million pounds.

CROP LOSSES DUE TO WEEDS

There are no accurate estimates of crop losses caused by weeds in the Sudan. The annual yield losses were conservatively estimated by Crammer (1967) to be 8%. The estimates of yield losses due to weeds made by FAO in 1972 were 8% for cotton, 12% for groundnuts, 10% for sesame, 6% for sorghum, 10% for millet and 2% for maize. Recently it was found that actual losses are higher than those listed above. Losses in crop yield due to unrestricted weed growth ranged from 18-100% (Table 2). Some crops such as wheat, sorghum, soybean, phillipesara and Dolichos lablab are able to smother weeds by their growing canopy but groundnuts, cotton, rice, sugar cane, kenaf and onions are sensitive to weed competition particularly during the early stages of growth.

The yield losses are mainly due to delayed weeding or insufficient weed control. A delay in weeding of cotton for 6 weeks after sowing can reduce yield by 35-40%. Insufficient weeding of cotton reduced yield by 30-50% (Hamdoun, 1977). When rain-fed groundnuts have not been weeded within 25 days of sowing, pod yields have been reduced by 320-430 kg/ha (Lea, 1954). Insufficient weed control caused a reduction in irrigated groundnut yield of 15-45% and that of rain-fed sorghum of 20-50%. Inadequate weed control in Jew's

Mallow and egg plants may reduce yield by 36-80% (Walter et al. 1984).

Yield losses caused by C.rotundus can be very severe. The presence of a high population lowers cotton yield by 90% (Last, 1959). Furthermore cotton, wheat and vegetables do not respond to nitrogen application in infested land.

Heavy infestations of S.hermonthica which parasitises sorghum, millet, maize and sugar cane can cause 70% loss in grain yield. Despite regular hand pulling of this weed negligible yields of sorghum and millet were obtained under central land conditions especially in seasons of lower rainfall.

Table 2. Loss in crop yield due to unrestricted weed growth.

Cotton (irrigated)	76	Hamdoun & Babiker, 1973
" (")	64	Jennings, 1974
" (")	64	Hamdoun, 1974
" (")	59	Hamdoun & Babiker, 1976
" (rain-fed)	100	Fageiry, 1981
" (")	100	Fageiry, 1982
Groundnuts	80	Ishag, 1971
	72	Jennings, 1974
	61	Hamdoun, 1976
Dolichos lablab	49	Idris, 1975
Sorghum	35	Ishag, 1968
	46	Hamdoun, 1977
Wheat	28	Ibrahim, 1973
Rice	69	Ghobrial, 1979
	75	Babiker, 1982
Soybean	33	Ageeb, 1978
Sugar cane	70	El Fadil, 1968
	50	Ibrahim, 1983
Onion	73	Babiker & Ahmed, 1985
Kenaf	83	Fageiry & El Hassan, 1978
Phillipesara	18	Idris, 1965

CULTURAL PRACTICES

The vegetable farmer and traditional farmer of the rainlands use simple cultural practices. The adoption of crop rotations is influenced by market, season, soil fertility, water, labour supply and weed problems. Land preparation consists of discing and/or ridging operations. Sowing is by hand. Vegetables are generally produced under pump irrigated conditions except for areas on the Nile banks where planting is carried out with the retreating water. Following crop sowing mineral fertilizers (mainly urea) are broadcast as a routine practice. Organic fertilizers are, however, used to a small extent. The use of pesticides is restricted to the application of insecticides. Harvesting is exclusively by hand. The traditional farmers in the rainlands never use fertilizers or pesticides. All crops are harvested by manual labour.

In the Gezira and other irrigated schemes seed bed is normally prepared by discing and ridging. Cotton, sorghum and groundnuts are

hand sown while wheat is normally drilled. Irrigation water is provided through a system of canals consisting of main canal, branch canals, major canals, minor canals, Abu XX's Abu VIs and field channels. Nitrogen as urea is applied on wheat at planting but applications on cotton are made 5-6 weeks after sowing. Other crops such as groundnuts and sorghum are not fertilized. Cotton, sorghum and most of the groundnuts is harvested by hand but wheat and some groundnuts are mechanically harvested.

The normal cultural practices in the mechanised crop production schemes consist of shallow disc harrowing with a wide level disc following adequate rainfall. Sorghum, sesame and cotton seeds are broadcast and buried. Cotton and sesame are harvested by manual labour. Sorghum heads are cut by hand and then mechanically threshed.

IMPORTANT WEEDS

Surveys carried out on vegetables, irrigated field crops, orchards and rain-fed cereals revealed that species dominance varies with locality, crop and availability of irrigation water. Major weed species are listed in Table 3.

NEW WEED PROBLEMS

It is fortunate that the Sudan has not so far been faced with new noxious weed species as a result of introduction of field, horticultural and forage crop seeds. The only occasion in which a new unidentified dicotyledonous weed species was observed was in 1975 when wheat (var. Giza 155) was introduced to the Gezira Scheme from Egypt. As soon as the weed was observed intensive hand pulling was made at regular intervals and that measure was sufficient for eradication.

LEGISLATION FOR WEED CONTROL

Though prevention of weed growth is better than cure, it is unfortunate that there is no noxious weed Act that makes it an offence to allow harmful weeds to set seeds and that specifies the degree of crop seed purity required and prohibits the sale and use of crop seed contaminated with seeds of certain weeds. The available legislation relates to water hyacinth and weeds that act as alternate hosts to major agricultural pests.

The water hyacinth act states that it is prohibited to transport a whole plant of the water hyacinth or portions of it to uninfested areas. This law was introduced to protect the clean tributaries of the Nile system as well as the irrigation canals of agricultural

schemes. A number of inspection and checking points have been established in strategic locations on land and river to enforce this law. The successful implementation of the law has kept the hyacinth away from the Gezira scheme and those along the Nile north of Jebel Aulia Dam.

The legislation relating to weeds as alternate hosts for agricultural pests states that the owner or occupier of any cultivated land should destroy all noxious weeds such as Abutilon spp, Callotropis procera, Hibiscus spp., and Sorghum halepense and other plants likely to harbour pests whether such plants are found upon land occupied by him or upon adjoining land and within a distance of 50 m from the boundary of cultivated land. For the implementation of this law regular campaigns are made by the Plant Protection Administration and land owners are advised or compelled to abide by this regulation. The successful implementation of the law has reduced infestations of spiny bollworm in cotton, Aphids and sorghum-stem borers.

WEED MANAGEMENT

Small scale farmer

The small scale farmer is entirely dependent on manual labour for weed control. Several hand-hoeings are generally made and their time and number varies with the crop and severity of weed infestation e.g. egg plants are weeded about 5 times while Jew's Mallow and rain-fed sorghum are weeded twice.

Irrigated schemes

Land allocated for cotton production in the Gezira scheme receives a deep blading operation to a depth below that of the lowest C.rotundus tubers during the hot dry summer. This operation which severs tuber roots, exposes the tubers to the sun causing death in 2 weeks, has proved to be an effective control measure for C.rotundus. Another practice adopted for control of weeds in cotton is summer watering and split-ridging. Fields are watered prior to sowing to germinate weed seeds and then ridges are split leading to effective control of early germinating weeds. A third mechanical control measure used in cotton is re-ridging at 5-6 weeks after sowing. This practice re-shapes the ridges, facilitates watering and controls weeds in the furrows.

The strategy adopted for controlling weeds in cotton since 1981 is to treat all irrigated areas with pre-emergence soil-acting herbicides.

A range of herbicide formulations and tank mixes are used in

Table 3. Major weed species in various crops

Weed Species	Vegetables	Irrigated Field Crops	Orchards	Rain-fed Cereals
Monocotyledons:				
Cynodon dactylon	x	x	x	-
Cyperus rotundus	x	x	x	-
Ischaemum afrum	x	x	x	x
Sorghum sudanense	-	x	-	x
Echinochloa colonum	x	x	-	x
Setaria verticillata	x	x	-	x
S.pallide-fusca	x	x	-	x
Dinebra retroflex	x	x	-	x
Panicum hygrocharis	-	x	-	x
Dicanthium annulatum	x	x	-	-
Dactyloctenium aegyptium	-	x	-	-
Rottboellia exaltata	-	-	-	x
Eleusine indica	-	-	-	x
Pennisetum sp.	-	-	-	x
Brachiaria eruciformis	x	x	-	-
Eragrostis cilianensis	x	-	x	x
Aristida spp.	x	-	x	x
Schoenfildia gracilis	x	-	x	-
Dicotyledons				
Amaranthus viridis	x	x	-	-
A.graecezans	x	x	-	-
Euphorbia spp.	x	x	-	-
Boerhavia diffusa	x	x	-	-
Crotalaria saltiana	x	-	-	-
Indigofera oblongifolia	x	-	-	-
Orobanche ramosa	x	-	-	-
Loranthus sp.	-	-	x	-
Phyllanthus niruri	x	x	-	x
P.maderaspatensis	x	x	-	x
Hibiscus sp.	x	x	-	x
Striga hermonthica	-	-	-	x
Acalypha indica	x	x	-	-
Ocimum basilicum	x	x	-	x
Ipomoea cordofana	x	x	-	x
Heliotropium sudanicum	x	x	-	-
H.supinum	x	x	-	-

Table 3. (cont).

Weed species	Vegetables	Irrigated Field Crops	Orchards	Rain-fed Cereals
Justicia palustris	-	x	-	-
Sida alba	x	x	-	-
Thunbergia annua	-	x	-	-
Rhyncosia memnonia	x	x	-	-
Corchorus tridens	x	x	-	x
Momordica balsamina	-	x	-	-
Eclipta prostrata	-	x	-	-
Sonchus cornutus	x	x	-	x
Aristolochia bracteolata	x	x	-	-
Leucas urticifolia	-	x	-	x
Digera alternifolia	-	-	-	x
Chrozophora plicata	x	x	-	-
Abutilon glaucum	x	x	-	-
Sesbania sesban	-	x	-	-
Solanum dubium	x	x	-	-

rotation so as to avoid carry over problems and the risk of a shift in the weed flora. Commercial use of herbicides in sorghum and groundnuts is limited to individual tenants.

Manual weed control is usually done after sowing by pulling or using hand hoes. The time and number of weedings varies with crop, season and the efficiency of the individual tenant. The number of weedings made in cotton, wheat, sorghum and groundnuts are 1,1,2 & 3-4 respectively.

Mechanized farms

The standard practice of weed control consists of 2-3 disc harrowings with wide level disc given after sufficient weed cover has developed following sufficient rainfall. After crop establishment sorghum is hand weeded once while cotton and sesame are weeded twice. Recently some farmers started to apply pre-emergence soil acting herbicides in sorghum and cotton.

Water hyacinth

The strategy of water hyacinth control in the White Nile and tributaries is based on intensive aerial spraying with 2,4-D in the sud region to reduce infestation and prevent excessive drift of the weed northwards. The floating weed mats as well as those along river banks are sprayed from mobile boats. Weeds anchored to the mud all along river banks are hand pulled, dried and burnt.

Aquatic weeds in the canalization system

An integrated approach for aquatic weed control in the canalization and drainage system is followed. Desilting of canals every 3-4 years with draglines results in effective control of submerged and emergent weeds. Manual measures that are frequently applied include chaining and raking of submerged weed species. More recently glyphosate has been sprayed for the control of emergent and bank weeds.

EXTENSION

Recommendation of weed management practices is the responsibility of the Crop Husbandry Committee of the Agricultural Research Corporation to which scientists submit their reports. Committee meetings are attended by scheme managements, extension specialists and plant protection personnel. Recommended practices such as deep blading and herbicide application in cotton are the responsibility of the management but pre-watering, split ridging, hand weeding and re-ridging are done by the tenant. Field inspectors are entrusted with supervision of the operations executed by the tenant and in the event of his failure to execute a certain operation, the field inspector does it on his behalf. Crops other than cotton are tenant crops and the management is only responsible for technical supervision and advice. The field inspectors and the limited number of extension personnel pay regular visits to the tenancies and villages and advise farmers on various agronomic and weed management practices. Moreover, information is disseminated through television, radio and press at regular intervals throughout the crop growing season. The various extension methods used have proved to be effective and efficient.

The vegetable grower and the traditional rainland farmer received little or no attention from the extension service in the past. Visits made by extension personnel to farmers in their fields or villages are infrequent due to transport difficulties. Dissemination of information through television, radio, press and posters is also infrequent. Such methods are not that efficient because most small scale farmers are illiterate and have no access to radio or television.

The mechanised farmers of the rainlands are literate, well off, have their own transport and regularly contact the manager of the mechanised farming corporation, the field inspector and the extension worker in their area. They are usually aware of recommendations pertaining to weed management practices but are always reluctant to implement them simply because they prefer to produce crops at minimum cost and make the maximum profit.

TRAINING

It is unfortunate that the teaching staff of agricultural colleges and institutes does not include a single weed scientist. Weed science courses at the B.Sc. and Diploma levels are generally taught by agronomists or botanists and such courses constitute a minor part of the syllabus in comparison to those on insect and disease control. The student therefore graduates with limited information on herbicides, their application and identification of weed species.

Regarding M.Sc. training the Faculty of Agriculture, University of Khartoum and that of the Gezira University run weed science courses under the joint supervision of a university lecturer and a weed scientist of the Agricultural Research Corporation. Such co-operation has been fruitful and resulted in the graduation of about 10 students in the last 4 years.

B.Sc. or Diploma holders working as field inspectors or in the extension service receive little or no training on weed management. Once every two years weed scientists of the Agricultural Research Corporation are invited to deliver a lecture to these trainers. Organised training involving weed identification, herbicides, application, mechanical, manual and biological control is non-existent.

ACCESS OF FARMERS TO WEEDS CONTROL PRODUCTS

Recommended herbicides for cotton are tendered for by scheme managements and are supplied by chemical firms. Herbicides for crops other than cotton are not available to the farmers because of foreign exchange difficulties.

The tenants in the irrigated schemes are at present not entrusted with the application of herbicides due to the possible hazards and crop phytotoxicity. The scheme managements execute field applications using their own tractors and sprayers. The chemical firms also provide sprayers to support the management efforts. As pre-emergence applications demand many tractor spraying units because of the vast areas to be treated, the short planting season

and the intermittent rainfall there is always a shortage of tractor mounted sprayers. This has forced the managements to apply pre-emergence herbicides as early as 4 weeks before crop sowing and to resort to aerial application in spite of the associated problems. Herbicide incorporation equipment such as tandom discs and rotavators are in short supply and this has led to abandonment of pre-plant incorporated herbicides. Knapsack sprayers are available in the country and are used by some vegetable farmers for spraying insecticides and herbicides.

RESEARCH IN WEED CONTROL

Progress in weed research in Sudan has been closely associated with progress and expansion of irrigated crop production particularly long staple cotton. Scientists engaged in weed control until the early sixties were only two. As a consequence of expansion in mechanized rain agriculture, development of new large production schemes viz. Suki and Rahad and the intensification of the Gezira rotation by reducing the fallows and introducing wheat, groundnuts and vegetables, more efforts were directed towards research personnel. At present there are 10 weed scientists with a Ph.D. or M.Sc. working full time in the various research stations. There is also an additional weed scientist studying for a Ph.D. at Reading University, U.K. Efforts of scientists are supported by 20 technicians and 30 apprentices.

Weed control units in each research station are equipped with knapsack sprayers, a balance and transport is provided by station directors when required. In the Gezira Research Station, however, the facilities are better. There is a large herbarium collection and a laboratory which is equipped with spectrophotometer, balances, glassware and reagents for analysis of herbicides in soil.

It is unfortunate that government support given to weed research is inadequate. The number of weed control specialists in the Agricultural Research Corporation is limited and some of the research stations are still without a scientist. The research funds and facilities are minimal.

Despite the above mentioned problems a number of achievements were made. Basic and background research has made some significant advances in understanding the biology of some important weed species such as C.dactylon, C.rotundus, I.afrum, S.hermonthica and Eichhornia crassipes. The weed species present in the various regions, cropping systems, the river and canalization system have been identified. The optimum number of weedings and their timing were established for some of the major crops. About 200 herbicide formulations and 90 tank mixtures were tested for weed control in

crops, aquatic and fallow weeds. Of these 20 have been recommended for commercial application in cotton, 11 in sugar cane, 8 in groundnuts, 9 in sorghum, 4 in onions, 4 in kenaf, 4 in rice, 3 in sesame, 2 in soya beans and 3 in sunflower. When herbicide applications were followed by a supplementary hand weeding for the control of resistant weed species the various crops were kept free of weeds until harvest and high levels of yield were maintained. The implementation of these findings in the irrigated and rain-fed crops resulted in good weed management and higher yields than the standard practices. Regarding perennial weed control deep blading and deep-ploughing followed by harrowing or rotavation were found to be effective for the control of C.rotundus and C.dactylon respectively. When those cultural practices were followed by post-emergence applications of glyphosate, fluazifop-butyl, haloxyfop-ethoxyethyl and quizalofop-ethyl outstanding control of C.dactylon was achieved. In the field of S.hermonthica it was found that planting tolerant cultivars such as Tetron, IS 9830 and SRN 39, the application of nitrogenous fertilizers and the adoption of rotations with a legume phase were found useful in reducing infestations.

LITERATURE ON WEED MANAGEMENT

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1. Weed Abstracts
2. Weed Science
3. Weed Research
4. Agronomy Journal
5. PANS
6. Pesticide Science
7. Journal of Agriculture & Food Chemistry
8. Residue Reviews
9. Canadian Journal of Botany
10. Annals of Botany
11. Botanical Reviews
12. Annals of Applied Biology
13. Annals of Plant Physiology
14. Experimental Agriculture
15. Sudan Agricultural Journal
16. Advances in Agronomy
17. Acta Horticulture
18. Journal of Horticultural Science
19. Tropical Pest Management
20. British Crop Protection Conferences-Weeds
21. Proceedings of the East African Weed Science Society Conferences
22. Proceedings of Soil Science Society of America

23. Proceedings of the International Symposia on Parasitic Weeds
24. Proceedings of the North Eastern Weed Science Society
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CONCLUSIONS AND SUGGESTIONS FOR IMPROVEMENT IN WEED MANAGEMENT

A few decades ago the farmer was able to solve his weed problems by abandoning the land and shifting to another. This practice has now become difficult due to increased human and animal populations. The lack of crop rotation, intensification, expansion of cropped areas, shortage of labour during the critical period of weed competition and the methods of weed control used have contributed to increased weed infestation which has become a real concern for the farmers throughout the Sudan. Economic losses caused by weeds are thus envisaged in the form of reduced agricultural production, incidence of disease among men and revenue loss. The attendant distress suffered by large sections of the population cannot be measured.

The available research results have clearly shown the importance of timely and proper weed control using cultural, chemical and manual methods. This package of recommendations has so far been implemented in the irrigated schemes on cotton. Weed management in other crops is not satisfactory.

Improvement of weed management could be made through good land preparation, adoption of a crop rotation, the use of herbicides and supplementary hand weeding. This objective can be achieved through intensive research on all aspects of chemical and mechanical weed control in the various regions of the Sudan. Research in the field of weed science should be strengthened. Programmes should be initiated to include biology, ecology and control using chemical methods as well as mechanical devices. Weed scientists should look

for herbicides that are relatively cheap and safe.

Land preparation and application equipment as well as herbicides should be made available.

Application of herbicides has to be made by highly trained and skilled personnel. This calls for intensive training at various levels. Weed science courses should be introduced to agricultural institutes and colleges, field staff and extension workers. Tractor drivers should be trained on herbicide application. The standard of literacy among the small scale farmers should be raised in order to make use of the limited extension service facilities. The extension service needs to be strengthened with trained personnel and equipped with vehicles cinemas, posters etc.

Noxious weed seed legislation is deemed necessary. The present act pertaining to water hyacinth and weeds that act as alternate hosts to pests should not be relaxed.

Improvement of weed management on the regional level can be made through conferences, visits of scientists to other countries in the region and the issuing of a weed science journal.

FURTHER INFORMATION

Herbicide usage for weed management is capital intensive and requires foreign exchange which is almost unavailable in the Sudan. The traditional method of hand weeding is, however, labour intensive. An intermediate technology involving the use of chemicals plus supportive handweeding is used in cotton. Before embarking on large scale application of one of those technologies its economics and effects must be considered. In the peasant farming community where family labour is abundant handweeding should be the weed management practice. In the irrigated schemes, mechanized farms and vegetable growing areas where labour is scarce and expensive and intermediate technology seems promising in controlling weeds and increasing crop yields. Dependence on chemical weed control alone should not be considered.

Not presented

WEED MANAGEMENT: COUNTRY STATUS PAPER - SYRIA

Mohieddin Hamidi
Directorate of Agricultural Scientific Research
P O Box 113
Damascus-Duma, Syria

INTRODUCTION

Syria has a very rich flora (wild and cultivated) because of the diversity of its climate and soil.

It is not uncommon to see our cultivated fields, orchards, waste places, road sides and channels full with many kinds of weeds. The main crops in Syria are:

Wheat, Barley, maize, cotton sugarbeet, legumes, vegetables (potatoes, tomatoes, cucumber and melons) olives and grapes and other fruit trees.

Out of the cultivated area, which is estimated as 5.9 million hectares, only 18% is irrigated. That area is concentrated in the following Governorates.

Hassaka, Aleppo, Rakka, Hama, Homs, Idleb, Damascus and Tartous. These are shown on the map in Fig.1.

Generally the majority of people working in Agriculture are small scale farmers with holdings ranging from 5 to 50 ha. About 50% of the total working force of this country is engaged in Agriculture.

THE WEED PROBLEM

The problem of weeds is one of the most important confronting those trying to increase Agricultural production.

The farmers start appreciating that importance when they see the higher production gained by the use of herbicides. But many of them are still not aware of the effects of weeds on the productivity of crops because these effects are not as conspicuous as those caused by insects and diseases.

However there are some cases in which the fields are completely infested with same weeds, such as Hordeum murinum in barley or orobanche in tomatoes, that draw weeds to the attention of the farmers and they ask for urgent solution. Responsible people working in agriculture appreciate the problem and do their best to control this pest.

Generally the government, through different public sectors like Agri-Directorates, Universities, Research Stations and extension units, is trying to bring the attention of the farmers to this problem and on its part is always offering to assist with herbicides, clean seeds and some publications.

We have already been asked by the Ministry of Agriculture to write a guide on weed identification and control. It is going to be published within a few weeks.

No studies in Syria assessing the losses caused by weeds have been published. But losses are certain to be very high.

CULTURAL PRACTICES

Ploughing and harrowing are the main cultural practices used in land preparation. The effect of the time in which these operations are carried out in relation to seeding and the rain has not been studied. Neither have the effects of these practices on the nature and distribution of the weed flora.

Flooding is one of irrigation methods practiced which aggravates the weed problem in some areas. The other methods are canal and drench irrigation.

The fertilizers commonly used are:

Ammonium nitrate	25%
Superphosphate	16-18% or 46-47%

The amounts applied depend on the kind of crops and soils. Since the Syrian soil is rich in potassium the use of potash fertilizer is limited to some areas which show a real response to this treatment.

The most common method for harvesting is by hand, however mechanical harvesting especially in wheat and barley is extensively used.

IMPORTANT WEEDS

The following is a list of the commonest weeds in cereals, legumes, vegetables, orchards etc.

1. Amaranthus sp.
2. Avena sterilis
3. Capsella bursa-pastoris
4. Carduus pycnocephalus (and many other thistles)
5. Chenopodium album
6. Convolvulus arvensis
7. Coronilla scropioides
8. Cuscuta sp.
9. Cynodon dactylon
10. Cyperus sp.
11. Digitaria sanguinalis
12. Echinochloa crus-galli
13. Euphorbia sp.
14. Glycyrrhiza glabra
15. Lolium sp.
16. Malva neglecta (M.rotundifolia)
17. Orobanche sp.
18. Phalaris sp.
19. Raphanus raphanistrum
20. Sinapis arvensis
21. Solanum nigrum
22. Sorghum halepense
23. Taraxicum officinale
24. Urtica arvensis

Out of this list few weeds can be considered such a potentially serious threat to crops as Orobanche sp. is to legumes and tomatoes especially on the sea coast. But others are very difficult to control, like Sorghum halepense, Cyperus sp., Cynodon dactylon and thistles.

In addition to that herbicides like U 46 seem to be losing their effects on broad leaves weeds in cereals. The same thing can be said of another herbicide, trifluralin, which is extensively used in cotton. These phenomena have not been studied and the only answer is to recommend another herbicide.

Hand weeding is the main method of weed control used, especially on small scale farms and in vegetables. However herbicides are the main tool in other situations (e.g. airports) and crops like cereals, sugarbeet and cotton.

CONCLUSIONS AND SUGGESTIONS

For the time being it is very difficult to solve all of our weed problems which depend on extensive studies.

The main reasons for this can be summarized as follows:

1. People are not interested in weeds.
2. A training course was run last year but it was the first one and ran for only a few weeks.
3. Research facilities are very limited and most research is done personally and is concentrated only on checking the efficiency of herbicides on weeds.
4. A national bibliography is not available and other references are very limited.

Finally we are ready to cooperate in a program for improving our situations. This could include work on the following aspects:

1. Planning weed control programs.
2. Training personnel in weed science and control techniques.
3. Provision of literature on weeds and weed control.

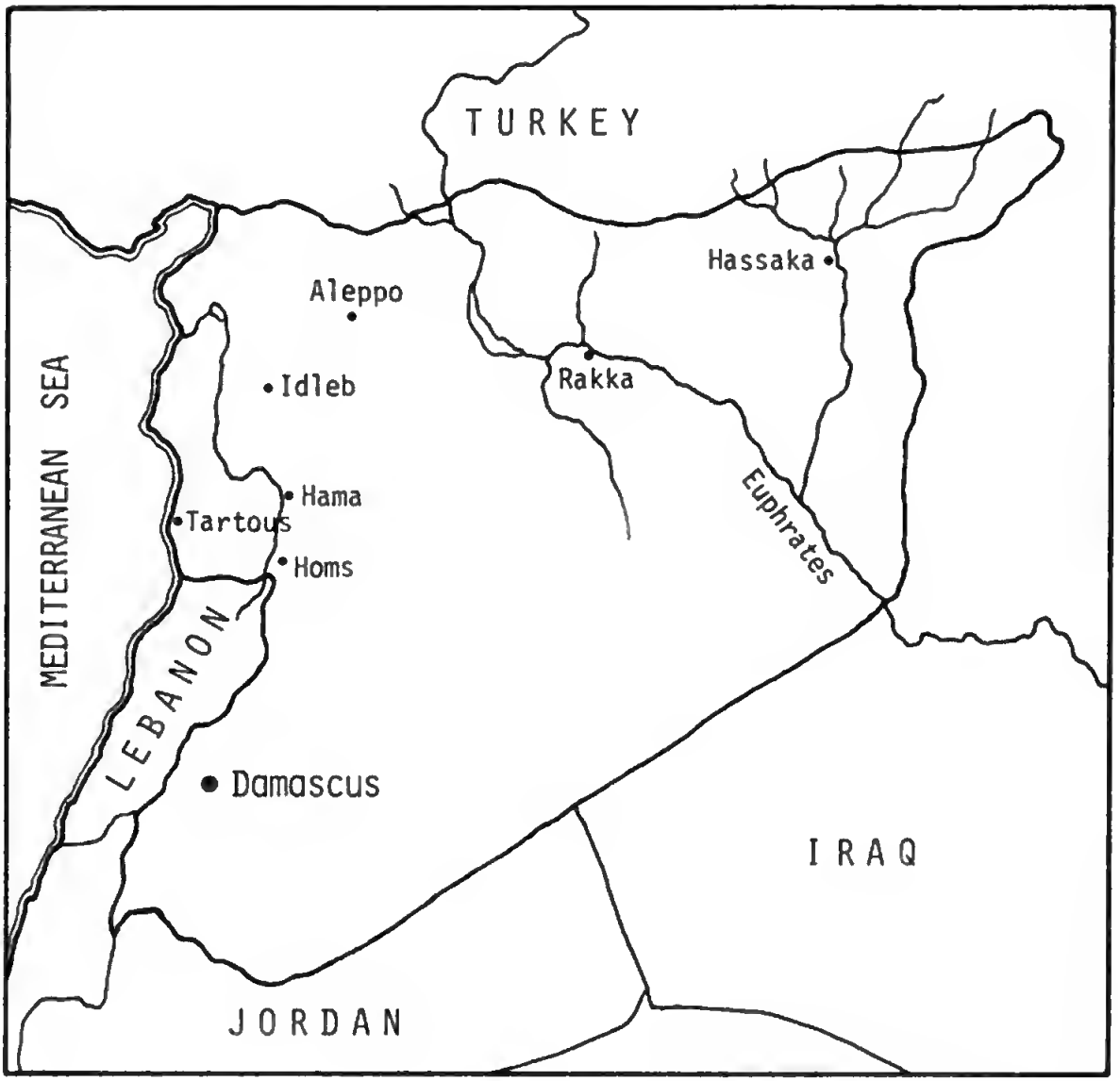

Fig.1. Map of Syria showing the Governorates with the main areas of irrigation.

Not presented

WEED MANAGEMENT: COUNTRY STATUS PAPER - TURKEY

M. Kurcman
Weed Control Laboratory
Regional Plant Protection Institute, Fatih Cad. 37
Kalaba, Ankara, Turkey

The first Regional Plant Protection Research Institute was established in 1934 in Ankara. Preliminary studies were carried out by Dr Bremer, a German who had come to Turkey to initiate phytopathological studies at that time. He made a collection of weeds of Turkey and with his assistant, Dr G. Kurhan, began to work with 2,4-D compounds in 1948. Dr Kurhan, being the first researcher to work on weed control, prepared the first doctorate study on weeds investigating the anatomic structure of weed seeds in cereal areas.

In 1955, the first Weed Control Laboratory in Turkey was established in the Ankara Institute and Dr Kurhan was Chief of the Institute until she retired in 1979.

Apart from the Ankara Institute there are now Regional Plant Protection Institutes with weed control laboratories at Adana, Izmir, Istanbul, Samsun, Diyarbakir and Erzincan provinces which were established between 1960 and 1970.

BACKGROUND INFORMATION ON AGRICULTURE

Cereals, mainly wheat, are the most important field crops in Turkey. There are also good plantations of fruit crops and vegetables (Table 1).

THE WEED PROBLEM

Farmers are used to coping with their weed problems and can manage them themselves. In the case of weed problems they fail to control they contact the government offices in their area. If no recommendation is available the Institutes carry out trials to solve the problem.

ASSESSMENT OF CROP LOSSES DUE TO WEEDS

Although crop losses due to weeds show great variation according to locality and the weed species present, the following are the average figures for no weed control areas:

Crops	Average losses (%)
Cereals	20-30
Garlic	89
Hibiscus	62
Carrot	39-59
Beans	23-42
Cucumber	43
Cabbage	35
Tomato	53
Cotton	20-90
Maize	13
Groundnuts	40-44
Rice	42-65
Caraway	100

CULTURAL PRACTICES

The effect of timely soil cultivation on the weed population is known even to small scale farmers. Cultivation, irrigation and fertilizing techniques to provide better weed control have been investigated by the Agricultural Research Institutes but chemical control has the most important role in weed management.

IMPORTANT WEEDS
(for Central Anatolia Region)

Cereals

Boreava orientalis, *Centaurea depressa*, *Bifora radians*, *Galium aparina*, *Sinapis arvensis*, *Cirsium arvense*, *Polygonum arenaria*, *Avena* spp., *Bromus tectorum*, *Gypsophila pillosa*, *Convolvulus arvensis*, *Turgenia latifolia*.

Vegetables

Amaranthus retroflexus, *Chenopodium album*, *Portulaca oleraceae*, *Xanthium macro carpum*, *Sinapis arvensis*, *Echinochloa crus-galli*, *Cirsium arvense*.

Fruits

Amaranthus retroflexus, Chenopodium album, Cirsium arvense, Alopecurus spp, Hordeum murinum, Plantago spp, Cynodon dactylon, Setaria spp, Echinochloa crus-galli, Chondrilla juncea, Lactuca scariola, Acroptilon picris, Cichorium intybus, Convolvulus arvensis.

NEW WEED PROBLEMS
(for Central Anatola Region)

Weed species resistant to 2,4-D compounds like Bifora radians, have become more dominant in cereals in the region. For the same reason graminaceous weeds have also reached high populations.

LEGISLATION FOR WEED CONTROL

It is obligatory to use certified growing material in many crops and there are many official seed centers supplying planting material free of weed seeds. However, this cannot be enforced in the case of small farmers.

WEED MANAGEMENT

Although hand weeding is applicable in small scale cultivation of crops such as vegetables, carrots, tobacco, etc., herbicides are widely used in many crops. Hoeing is also very important in crops grown in rows.

EXTENSION

There are experienced technical personnel based in towns and provinces who cooperate closely with the farmers. They prepare extension courses to make the farmers more conscious of weed problems as well of diseases and pests.

These training activities include lectures with slides, printed material and demonstrations. It can be said to be sufficient for weed control.

TRAINING

Training of instructors is carried out in Regional Research Institutes for a period of two weeks once a year.

ACCESS OF FARMERS TO WEED CONTROL PRODUCTS

Although there are some problems in maintaining supplies of herbicides and application equipment for the small scale farmers, conditions for big farmers and farmers in cooperatives are good.

RESEARCH IN WEED CONTROL

There are seven Regional Plant Protection Institutes in Turkey each with a weed control laboratory to deal with regional problems. People working in these laboratories gather once a year to discuss the problems and the projects carried out or to be started. Insufficient technical staff and funds are the limiting factors of weed research

LITERATURE ON WEED MANAGEMENT

There are several Turkish Documentation Centers from which any reference can be supplied. These Centers are in contact with others abroad.

CONCLUSIONS AND SUGGESTIONS

The number of technical staff working at Weed Control Laboratories and Centres dealing with research and application should be increased. Necessary research should be carried out to reduce the amount of herbicide use and more attention should be paid to problems of herbicide residues.

FURTHER INFORMATION/COMMENTS

The FAO Expert Consultation is welcomed since it is a very important step towards better weed control in the Near East. It will give very good results in the analysis and interpretation of the problems of the Region.

SECTION E

ANNEXES

AGENDA

Wednesday, 30 October

Opening of Consultation

Future Trends in Agricultural Production within the Arab Countries

Dr. E.S.E. Azrag (AOAD)

Weed Management in Dryland Cereal Production with Special Reference to the Near East

Dr. S. Kukula (ICARDA)

Improved Weed Management in Vegetable Production

Dr. A.R. Saghir (ASPP)

Appropriate Weed Management Practices in Orchards

Mr. S. Collins (GIFAP)

Aspects for Weed Management Considering Alteration of a Traditional Cropping System

Drs. H.G. and A.E. Jansen (GTZ)

Thursday, 31 October

Parasitic Weeds and their Control in the Near East

Mr. C. Parker and Mrs. A. Wilson

Country status paper Cyprus	Mr. P. Americanos & Mr. G. Markoullis
Country status paper Egypt	Dr. T. Ibrahim
Country status paper Iran	Mr. H. Mirkamali
Country status paper Iraq	Mr. K. Al Kaisi
Country status paper Jordan	Dr. B. Abu-Irmaileh
Country status paper Lebanon	Dr. A.R. Saghir
Country status paper Morocco	Mr. M. Mouch
Country status paper Pakistan	Dr. R.A. Shad
Country status paper Sudan	Dr. A. Hamdoun

Storage and Distribution of Weed Management Data

Dr. W. Koch

Discussion session

Friday, 1 November

Discussion of conclusions and recommendations

Adoption of report

Closure of Meeting

LIST OF PARTICIPANTS

Dr. B.E. Abu-Irmaileh	Associate Professor Faculty of Agriculture University of Jordan Amman, Jordan
Mr. K.M. Alkaisi	Agricultural Engineer Plant Protection Research Centre Abu Ghraib, Iraq
Mr. P.G. Americanos	Agricultural Research Officer Agricultural Research Institute Nicosia, Cyprus
Dr. E.S.E. Azrag	Head, Agricultural Mechanization Unit AOAD 4 Gama'a Street PO Box 474 Khartoum, Sudan
Mr. S. Collins	GIFAP Representative c/o Monsanto Agricultural Chemical Co. BP No. 70 38290 La Verpilliere, France
Dr. L. Ebner	EWRS Representative Head R and D Ciba-Geigy Ltd. Basel, Switzerland
Dr. A.M. Hamdoun	Research Professor of Weed Science Gezira Research Station Wad Medani, Sudan
Dr. T.S.E.N. Ibrahim	Head of Weed Control Research Sakha Agricultural Research Station Kafr, El Sheikh, Eqypt
Dr. A.E. Jansen	GTZ PO Box 5180 D6236 Eschborn 1 Federal Republic of Germany
Dr. H.G. Jansen	GTZ PO Box 5180 D6236 Eschborn 1 Federal Republic of Germany

Dr. W. Koch	Professor of Weed Science University of Hohenheim 380 PO Box 700562 7000 Stuttgart 70 Federal Republic of Germany
Dr. S. Kukula	Agronomist ICARDA PO Box 5466 Aleppo, Syria
Mr. G.P. Markoullis	Agricultural Officer Plant Protection Section Department of Agriculture Nicosia, Cyprus
Mr. S.H. Mirkamali	Weed Specialist Weed Research Department PO Box 1454 Tehran 19395, Iran
Mr. M. Mouch	Inspecteur Direction de la Protection des Vegetaux BP 415 Rabat, Maroc
Mr. C. Parker	Head, Tropical Weeds Group Weed Research Division Long Ashton Research Station Long Ashton, Bristol BS18 9AF, UK
Dr. A.R. Saghir	Professor of Weed Science Faculty of Agriculture American University of Beirut Beirut, Lebanon
Dr. R.A. Shad	National Coordinator (Weed Science) National Agricultural Research Centre P.O. NIH Park Road Islamabad, Pakistan

FAO SECRETARIAT

Mr. L.J. Matthews	Weed Specialist FAO Via delle Terme di Caracalla 00100 Rome, Italy
Dr. M.M. Taher	Regional Plant Protection Officer for the Near East FAO Via delle Terme di Caracalla 00100 Rome, Italy

OBSERVERS

Dr. I. Melifronides	Entomologist Department of Agriculture Nicosia, Cyprus
Dr. G. Orphanides	Head, Plant Protection Section Agricultural Research Institute Nicosia, Cyprus
Dr. J. Zyngas	Head, Plant Protection Section Department of Agriculture Nicosia, Cyprus

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